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INNOVATIVE APPROACHES FOR VALUING
PERCEIVED ENVIRONMENTAL QUALITY

METHODS FOR MEASURING NON-USE VALUES: A CONTINGENT VALUATION STUDY OF GROUNDWATER CLEANUP

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ABSTRACT

This study constitutes the third in a series of studies conducted for the USEPA exploring the use of the contingent valuation method (CVM) for valuing environmental benefits. The CVM is the only methodology now available for measuring non-use benefits which likely comprise a large portion of values for environmental commodities. The measurement of the total benefits (including use, altruistic, bequest and existence values) of cleaning up contaminated groundwater is necessary to evaluate a variety of programs including Superfund (CERCLA) and the Resource Conservation and Recovery Act (RCRA). In particular EPA has proposed a comprehensive regulatory framework for corrective action (55FR:30798-30884. July 27, 1990) based on the Hazardous and Solid Waste Amendments to RCRA of 1984 which broadened EPA's authority to include releases from all solid waste management units. The Office of Solid Waste is in the process of conducting a Regulatory Impact Assessment of this proposed rule which includes the costs and benefits of corrective actions regarding groundwater contamination. Thus, one immediate purpose of this study is to provide information for estimating the benefits of groundwater cleanup.

A theoretical model of the benefits from cleaning up groundwater shows that careful survey design is imperative to the measurement and estimation of values. Interdependent utilities (in the case of non-paternalistic altruism) generate values that may result in double-counting if the method of payment is not specified in the survey instrument (ie., one household need not pay to help another if the recipient household is able to pay to help itself). Intergenerational non-paternalistic altruism may also lead to double counting if benefits are summed for more than one generation (ie., if parents have paid to protect their children's interests, the children's values should not be counted again). Furthermore, an inherent confounding of bequest and existence values exists which suggests that these are best measured jointly. Paternalistic altruism for environmental goods and imperfect water markets leading to overuse today are also shown to be appropriate motivations for bequest values and some respondents were clearly motiviated by these concerns.

We then summarize what our studies have shown about measuring non-use values using the contingent valuation method (CVM). It is our view that there exists a fundamental difference between attempts to measure use and non-use (altruistic. bequest and existence) values, because respondents to surveys evaluating non-use values are in some cases uninformed about the commodity which they are asked to value. Thus, for non-use values, the burden of informing respondents about all aspects of the commodity falls on the survey instrument. In the case of non-use values, many respondents may not have the information necessaryto construct a meaningful value. Thus, since the survey instrument itself must provide the information necessary for respondents to construct values, opportunity for bias exists in the survey design if anything less than perfect Information is provided. Perfect

information includes, for example, not only information on the commodity itself, but also information on substitute commodities, how changes in the level of provision of the commodity will affect the respondent etc. In addition. perfect information implies the necessity of providing the complete psychological context of the economic decision.

Although it may seem that the requirements of perfect information and complete context provide an impossible burden on survey design, the study described here suggests an approach which may both avoid bias and provide a survey of practical length. This process draws much from a new area, cognitive survey design. First, a perfect information, complete context instrument is designed. Ideally, an expert panel would provide the necessary information The Office of Solid Waste at the USEPA served that role for us and provided a range of scenarios for valuation reflecting technical uncertainties. This instrument, while infeasible for field use (potentially, containing as much as 30 to 40 pages of material), can be used in pretesting where subjects are paid to "become experts." Both think-aloud verbal protocols and retrospective reports (wherein subjects speak continuously into a tape recorder while answering the survey or discussing what they were thinking while filling out the survey after the fact) are then utilized to identify problems with scenario rejection, embedding, etc., and to provide insight into critical information problems (ie., areas where mis-information exists). After redesign based on the verbal protocols and retrospective reports, this full information/complete context instrument is applied in a self-administered format to a large enough random sample of individuals so that a statistically meaningful estimate of values can be obtained. These respondents then answer a debriefing survey and are asked what information/context was used in constructing their values. Based on these self-reports, little used or unused information/context is removed in redesigning a more compact survey instrument. The redesigned instrument is then readministered to a new random sample of respondents and the stability of the distribution of values (as compared to the longer original instrument) can be tested. Using this approach we show that informed/full context values have a much smaller variance in values and a substantially lower mean value than uninformed values. Evidence is also presented (1) on the nature of measurement errors resulting from the use of hypothetical questions (these are shown to be right skewed). (2) on embedding (additional information and context are shown to reduce embedding) and (3) on scenario rejection.

A national mailing was undertaken to 5000 households using the shortened survey which resulted in a response rate of about 60%. Econometric analysis of the national mall survey was used to correct for possible measurement error (using a Box-Cox transformation). Three alternative approaches for calculating non-use values are shown to have provided remarkably consistent estimates of such values. All variants of the survey valued complete cleanup. Different variants also asked for the value of alternative programs. These alternative programs included a containment strategy in one case and a public water treatment program in another. A third variant of the survey investigated the change in willingness to pay as the degree of water shortage assodated with groundwater contamination changes. A final version of the survey investigated the willingness to pay for helping to clean up groungwater on a national basis. 'Ibis last version was also used to oversample areas known to have contaminated groundwater and to further investigate the effects of different levels of information and contact in the survey instrument on value construction.

Additional research is suggested to consider the question of the appropriate market size for the application of the values in estimating national benefits. In addition. econometric methods will have to be developed to deal with situations in which willingness to pay with many true zero bids occurs with right-skewed errors.

By accepting the notion that non-use values must usually be constructed by respondents rather than assuming values preexist. several important philosophical questions arise. The political process often considers motives or values of the type economists consider to be measured in dollar estimates of non-use values. When parklands are set aside for the enjoyment of future generations and the preservation of wilderness, bequest and existence motives clearly reside in the minds of both constituents and their representatives. These motives, however, because of lack of choice experience, real world context and information may share many of the characteristics of what we have termed limited information/limtted context values. In other words, political preferences themselves maybe as incoherent and inconsistent as the contingent values challenged by critics of the CVM.

How might the use of the potentially coherent, consistent values which are created by the process we have outlined be justified? It has long been recognized that rapid changes in measures of attitudes can occur during a political process. However, as more is revealed about the issues (possibly equivalent to the development of full information/Ml context). attitudes crystallize, become stable and relatively constant over time. We would argue that economic values go through a similar process of crystallization. The appropriate goal, we would argue, for the CVM is to attempt to provide crystallized values for public decisionmaking. We hope to have suggested an unbiased process through which such values might be obtained.

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Chapter I

Introduction

This study is the third in a series of USEPA funded studies exploring the use of the contingent valuation method (CVM) for valuing environmental benefits[1]. The larger goals of this research have been to identify both what constitutes an acceptable contingent valuation (CV) study and to determine what the requirements are for reliable measurement of non-use as opposed to use values. The measurement of non-use values has become controversial and this study, building on prior work (which principally examined use values for air quality improvements). focuses on methodological issues in measuring non-use values for groundwater cleanup.

The benefits of groundwater cleanup are of interest to EPA in evaluating a variety of programs including Superfund (CERCLA) as well as the Resource Conservation and Recovery Act (RCRA). In particular EPA has proposed a comprehensive regulatory framework for corrective action (55FR:30798-30884, July 27, 1990) based on the Hazardous and Solid Waste Amendments to RCRA of 19S4 which broadened EPA's authority to include releases from all solid waste management units. The Office of Solid Waste is in the process of conducting aRegulatory Impact Assessment of this proposed rule which includes the costs and benefits of corrective

1 see, Schulze, et. al., 1990, and McClelland, et. al., 1991.

actions regarding groundwater contamination. Thus, one immediate purpose of this study is to provide information for estimating the benefits of groundwater cleanup.

The report is organized as follows: Chapter II defines the sources of benefits which might arise from groundwater cleanup and analyzes a number of theoretical issues relevant to the measurement and estimation of benefits, especially as regards non-use values. Given the controversy surrounding the measurement of non-use values, Chapter III summarizes our methodological research Into the roles of information and context, embedding, hypothetical error, and scenario rejection. Chapter III also seines as a summary of our research tidings on non-use values for groundwater cleanup. Chapter IV = details our initial research and pretesting of a perfect information/full context survey instrument while Chapter V presents the design and pretesting of the mail survey Instrument. Chapters VI and VII present and analyze the results of a national mail survey estimating groundwater values. Chapter VIII discusses limitations of the study as well as suggestions for future research.

Chapter II

A Theoretical Basis for Estimating the Benefits of Groundwater Cleanup

2.1 Introduction

The total value of groundwater cleanup or preservation can be defined as consisting of four components:

- Use Value - the direct value to each household for the clean water they consume themselves (including any adjustment for uncertainty which has been termed option value):

- Altruistic Value - the value that households place on other households having clean groundwater today:

- Bequest Value - the value that the current generation places on the addability of clean groundwater to future generations:

- Existence Value - the value that individuals place on simply knowing that groundwater is clean independent of any use, i.e., the value that would remain for cleanup even if people never used the water.

The latter three categories are generally termed non-use values (see Krutilla, 1967). The application of these value measures in the case of groundwater is not as straightforward as might be supposed. This occurs both because of a possible confounding of use, altruistic, bequest values and existence values and because water markets themselves are highly imperfect.

2.2- A Model of Intergenerational Choice

To explore these issues, we construct a model of intergenerational choice which allows both for groundwater cleanup and assumes that the utility of the present generation (denoted as generation 1) depends on the utility of future generations (collapsed for simplicity into one future generation, generation 2). Thus, we begin the analysis with the assumption of non-paternalism (see Archibald and Donaldson, 1976). That is, generation 1 cares only about generation 2s utility, not about their specific pattern of consumption, Le., generation 1 respects generation 2s tastes. We explore paternalism later since this issue is central to the application of bequest values for groundwater in benefit - cost analysis. In the model let:

X^o	=	initial stock of clean groundwater.
Z^o	=	initial stock of contaminated groundwater.
D	=	amount of groundwater which is decontaminated.
z	=	Z^o - D = groundwater which remains contaminated.
W_1	=	water use now.
W_2	=	water use in the future.

C_1 = consumption now,
C_2 = consumption in the future,
Y_1 = income now,
Y_2 = income in the future,
r = interest rate,
$U^1(W_1, C_1, Z, U^2)$ = utility now ($U^1_w, U^1_C, U^1_2 > 0$; $U^1_Z < 0$).[1]
$U^2(W_2, C_2, Z)$ = utility in the future ($U^2_w, U^2_C > 0$ $U^2_Z < 0$),
$E(D)$ = cost (expense) of decontamination (E', $E'' > 0$).[2]

Note that we assume that generation one's utility, U^1, is an increasing function of their own use of groundwater, W_1, their own dollar valued consumption, Cl, and the next generation's utility. U^2. It is also a decreasing function of the amount of contaminated groundwater remaining after decontamination efforts, $Z = Z^0 - D$. The cost of decontamination incurred by generation 1, E(D), is assumed to increase at an increasing rate and approaches infinity as $D \rightarrow Z^0$. The utility of future generation, U^2, is a function of their own water use, W_2, consumption, C_2, and the remaining stock of contaminated groundwater, Z. Any direct disutility to both generations from Z provides a source for existence value in the model. Note that we exclude altruistic value as defined above from this analysis by not explicitly modeling individuals within generation 1 and 2 who may have altruistic preferences for each other. Madariaga and McConnell (1987) and Jones-Lee (1991, 1992) have examined this case in detail and we will summarize their results later.

Two constraints apply to this intergenerational choice problem. First, the availability of groundwater must be defined for the present and future generations. To simplify matters for theoretical purposes, we assume that

1 Subscripts denote partial derivatives.
2 Primes denote **derivatives.**

no recharge occurs, so groundwater, which is also the only source of water, is "mined." This implies that

$$(1) \quad X^o + D \geq W_1 + W_2.$$

so the initial stock of clean water, X^0, plus the amount of decontaminated water, D, is available for use now and in the future. Second, the intertemporal budget constraint must be specified. This takes the form

$$(2) \quad (1+r)\,[Y_1 - C_1 - E(D)] + Y_2 - C_2 \geq 0,$$

so any savings out of the first generations income, Y_1, after they spend Cl and E(D), accrue Interest at rate r and are available to future generations to increase their consumption, C_2, above their initial income, Y_2. Thus, we assume that perfect intertemporal capital markets exist across generations.

Given our assumption of non-paternalistic intergenerational altruism, no intertemporal planning inconsistency exists (Blackorby, et al., 1973), so an efficient solution can be obtained by maximizing the first generation's utility,

$$(3) \quad U^1(W_1, C_1, Z^o\text{-}D \;\; U^2(W_2, C_2, Z^o\text{-}D)).$$

alone (since they must decidehow much cleanup to fund), subject to constraints (1) and (2) specified above. Note that generation 1 chooses both for itself and the future but because of non-paternalism, given the resources left to it generation 2 voluntarily makes the same choices as made for it by generation 1. Two conditions which emerge from the solution, where we rule out comer solutions and assume the contraints are binding, are of special interest. First, the condition for optimal use of groundwater over time,

$$(4) \qquad \frac{U_w^1}{U_c^1}(1+r) = \frac{U_w^2}{U_c^2},$$

can be interpreted as a Hotelling condition such that the price or value placed on water at the margin by generation two (U_w^2/U_c^2) is equal to the marginal value (or price of water) for generation one (U_w^1/U_c^1) increased by the intergenerational interest rate. Thus, the price of water must increase at the rate of interest over time and, for efficiency, a perfect intertemporal market for water (obviously an unrealistic assumption which we consider later) in which the relative values and use now and in the future are balanced by the interest rate must exist. Given (4). wc can write the second condition of interest, that for the optimal level of decontamination, D, as

$$(5) \qquad \left[\frac{U_z^1}{U_c^1} + \left(\frac{1}{1+r}\right)\frac{U_z^2}{U_c^2}\right] + \left[\frac{U_w^1}{U_c^1}\right] = E'.$$

(a) (b) (c)

where the left hand side consists of the marginal benefits of groundwater cleanup and the right hand Side (term (c)) is the marginal cost of cleanup. Term (a) is, unsurprisingly, the discounted present value of marginal existence values over the present and future generation. Term (b), on the other hand, is something of a surprise just reflecting generation ends use value of water with no adjustment whatsoever for bequest value. In other words. With non-paternalistic altruism and perfect water markets bequest values should not be considered in benefit-cost analysis of groundwater cleanup[3]. This occurs because, with perfect water markets, the price of water today, term (b) in equation (5), fully reflects' the opportunity cost of groundwater in future use as determined in the intertemporal water use tradeoff of equation (4). Since many CV studies have estimated large bequest values, this raises the question as to whether or not such values should be incorporated in the benefits of groundwater cleanup. In what follows we relax each of the assumptions required for this result. However, before relaxing these assumptions, we must point out a fundamental confounding of existence and bequest values which results from non-paternalistic altruism. In term (a) of equation 5, which we have defined as existence value, the discounted present value of the second generation's existence value is present solely as a result of the altruism of generation 1 for generation 2. Thus, the expression $(\frac{1}{1+r})(U_z^2/U_c^2)$ could be considered a form of bequest value. Given this confounding, attempts to ask survey respondents to accurately provide separate estimates of bequest and existence values are likely to fail.

Can bequest values result from imperfect water markets? The relevance of this question can be illustrated by water use patterns in

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[3] **In stating that "*In the extended model in which some citizens may be concerned about the happiness of others, the part of willingness-to-pay that arises on account of altruistic feelings must be excluded from the benefit-cost calculation in order to identify correctly the projects that are potential Pareto improvements*" Milgrom reaches the same conclusions (Milgrom, 1992, p. S, italics in original) which has been available in the public goods literature for many years (see Hochman and Rodgers (1%9) and Daly and Giertz (1972)) as WC(I as the CVM literature (see Madariaga and McConnell (1987)). However, based on a simple illustrative example, Milgrom shows that non-paternalistic altruism should not be double counted without acknowledging the possibility of either intra- or inter-generational paternalistic altruism and thus incorrectly rejects all altruistic benefits from benefit-cost analysis. Similarly, he fails to consider the impact of imperfect natural resource markets resulting in current overconsumption, an issue which we address below.**

California which recently suffered from a prolonged drought. Water users in central valley communities such as Sacramento are unmetered and consequently continued to use more than twice as much water per capita as neighboring communities with meters and priced water. At the same time, water intensive, low profit crops have continued to use vast quantities of subsidized water in spite of the water "shortage" (e.g., rice, a major California crop which requires 1.600 gallons of water per dollar of rice produced). Many communities have been forced to increase their dependence on and use of groundwater under these circumstances. Many of our respondents were concerned about the availability of groundwater in the future because of perceived overuse today.

One way to account for over-consumption of groundwater by generation 1 in the model developed above is to add an additional constraint which “forces” use by generation 1 to exceed the efficient level. This constraint takes the form:

$$(6) \quad W_1 \geq \bar{W}$$

where $\bar{W}$ is an inefficiently high level of use for generation one. In maximizing (3) subject to (1), (2) and (6) the new conditions for water use and decontamination take the form:

$$(7) \qquad \frac{U_w^1}{U_c^1}(1+r) < \frac{U_w^2}{U_c^2} \quad \text{and}$$

$$(8) \quad -\left[\frac{U_z^1}{U_c^1} + \left(\frac{1}{1+r}\right)\frac{U_z^2}{U_c^2}\right] \qquad + \left(\frac{1}{1+r}\right)\left[\frac{U_w^2}{U_c^2}\right] \quad = E'.$$

(a) (b) (c)

In (7) the marginal value of groundwater to future generations (U_W^2/U_C^2) can now be arbitrary high relative to the marginal value to the present generation (U_W^1/U_C^1) depending on how short the future supply of groundwater is as a result of current over-consumption. The failure of equality to hold in (7) implies an important change in (8) as well. Term (b) which was current use value in (5) is now replaced by the present value of future use value. A bequest value can now be derived as follows. The left hand side of (8) represents marginal benefits. The benefits of groundwater cleanup in this model consist of use value to the present generation, bequest value and existence value. These three components can be defined at the margin as

(9) use value = (U_W^1/U_C^1)

(10) bequest value = $\left(\frac{1}{1+r}\right)(U_W^2/U_C^2) - (U_W^1/U_C^1)$

and (11) existence value = $-\left[\frac{U_z^1}{U_c^1} + \left(\frac{1}{1+r}\right)\frac{U_z^2}{U_c^2}\right]$

which sum to the left hand side of (8). Note that if (7) holds with equality, i.e., water markets are perfect and the present generation is not over-exploiting groundwater, bequest value is zero in (10). Bequest values arise from current over-exploitation which raises the discounted present value of future water use above the value of current water use as shown in (7). The differential is the extra Willingness to pay by the current generation, above their own use value, to redress the inefficiency of over-exploitation of the resource. In spite of the awkwardness of defining bequest values in this way, this argument is consistent with the underlying psychology of bequest values in which people today are worried that insufficient resources will be left to future generations. This worry is justified by the introduction of market failures which result in over-exploitation of non-renewable or renewable natural resources.

Another source for bequest values which might be appropriately added to use value arises when the current generation has paternalistic preferences with respect to fixture generations. In this case, the current generation might respect the preferences of future generations over personal consumption but feel some special obligation to provide a clean environment. Water, land, air, and wild species could thus be viewed as somehow different from other "commodities" and merit special concern and stewardship by one generation for the next. As shown in Chapter 3, where we discuss the verbal protocols, many respondents rejected the notion of compensating future generations with money. Rather, many individuals preferred to cleanup groundwater today - direct evidence for non-paternalistic altruism with respect to groundwater. To capture this possible "special" concern beyond non-paternalistic altruism, we modify the utility function of the first generation to include W_2, consumption of groundwater by generation 2, as a direct argument as well as by continuing to include W_2 indirectly as part of the second generations utility function. Thus, (3) is replaced by

(12) $U^1(W_1, W_2, C_1, Z^o - D. U^2 (W^2, C_2, 2P-D))$

for maximization subject to (1), (2) and (3). We continue to assume water market failure. The condition of interest for D. the amount of decontamination, takes the form:

$$(13)\quad -\left[\frac{U_z^1}{U_c^1} + \left(\frac{1}{1+r}\right)\left(\frac{U_z^2}{U_c^2}\right)\right] + \left(\frac{1}{1+r}\right)\left(\frac{U_{w_2}^2}{U_c^2}\right) + \left(\frac{U_{w_2}^1}{U_c^1}\right) = E'.$$

(a) (b) (c)

Term (a) again provides existence value, term (b) incorporates both use value and any bequest value arising from water market failure, while term (c) provides a paternalistic bequest value for availability of water to future generations. An important point is that this paternalistic bequest value is not discounted at the market rate of interest, r, which does however apply to term (b). Thus, this source of value, if present, could be large for some types of natural resources. It should be noted that the empirical issue of paternalism has provoked considerable debate (e.g., that between Pollack and Becker). However, because of the obvious altruism of parents towards their children, some type of intergenerational altruism is generally assumed to exist. In the design of our surveyinstrument, described in the following chapters, we will carefully define bequest values for respondents, both because of the issue of paternalism and because intergenerational interdependence does present the possibility of the double counting of benefits.

Double counting may arise with non-paternalistic altruism if one evaluates the benefits of cleaning up an unusable aquifer by taking the discounted present value of use values over time beyond the life span of the present generation. If use values are discounted and totaled as the water is extracted (say, over two generations) and one then adds bequest value of generation one which arises from over-exploitation to this figure, the value to the second generation will be counted twice. Assuming non-paternalistic altruism, if the use value analysis over two generations properly accounts for the increase in value to the second generation due to scarcity introduced by over-exploitation, an alternative measure of bequest value is already included. In other words, the bequest and use value of generation one measured by term (b) in (13) already accounts for the use value of the next generation. Paternalistic bequest values are not subject to this double counting problem. To be conservative the future discounted present value of use values should not be added to bequest values. These points are a straightforward extension of those made by Madariaga and McConnell (1987) for the case of altruistic values. They also argue that double counting can result for these values in benefit-cost analysis.

Finally. Madariaga and McConnell demonstrate that the assumptions presented in a CV study about who pays for environmental improvements can affect bids just as their theory and the arguments of Jones-Lee suggest. From a theoretical perspective respondents in the case of altruistic values should be informed that everyoneepays for cleanup. In this situation, with non-paternalistic altruism, no bequest values should be present. However. the results of this study suggest that paternalistic motives are present among some respondents.

2.3 Conclusions

The conclusions which can be drawn from theory that are relevant for survey design and benefit estimations are as follows:

- The method of payment by others for groundwater cleanup must be specified so that, in the case of non-paternalistic altruism, altruistic values will not be overstated by respondents (Madariaga and McConnell). otherwise respondents may assume that the cleanup for others will not occur unless they themselves pay for it. Our surveys are designed so that cleanup scenarios are funded by an. increase in water bills for everyone.

- Bequest values (intergenerational altruism) may suffer from the same type of double counting as proposed by Madariaga and McConnell. Thus, only the values of the present generation should be considered for benefit-cost analysis. The survey design should specify a payment period (say 10 years) over which cleanup will be completely paid for. A conservative approach is to assume that the discounted present value over this period (say 10 years) for those payments constitutes the entire benefit stream.

- Given intergenerational altruism, bequest and existence values are inherently confounded in a way that respondents arc unlikely to understand unless trained in economic theory. Thus, these, sources of non-use values are best estimated jointly.

- Bequest values may arise solely because of a belief that the present generation is overusing groundwater resources today.

Chapter III

Methodological Issues in Using Contingent Valuation to Measure Non-Use Values

3.1 Introduction

The usefulness of the Contingent Valuation Method (CVM) for estimating non-use values has come under attack[1] . This chapter summarizes what has been learned about the CVM in a series of USEPA funded studies which have had as their goal both an assessment of: (1) what constitutes an acceptable CV study and (2) how the nature of the commodity to be valued affects that acceptability. The groundwater study reported herein is the latest in this series. In our view, there exists a fundamental difference between attempts to measure use and non-use (bequest and existence) values because respondents to surveys evaluating non-use values are essentially uninformed about the commodity which they are asked to value. Thus, for non-use values, the burden of Informing respondents about all aspects of the commodity falls on the survey instrument. In the case of

[1]For example, Diamond and Hausman (1992) concluded. based on an assessment funded by EXXON which involved a lengthy list of other collaborators, that "CV does not provide a reliable method to calculate natural resource damages. The inevitable outcome is great uncertainty about the level of damages which maybe assessed since a clearly defined correct method of doing CV evaluations IS only a figment of CV proponents imaginations". (Diamond and Hausman, p. 32-33)

non-use values, many respondents may not have the information necessary to construct a meaningful value.

Use values, by their very nature, suffer less from this problem because respondents are familiar with the sommodity and have a real world decision context to frame their value. In the case of non-use values, the survey instrument itself must provide the information necessary for respondents to construct values. Therefore, the opportunity for bias exists in the survey design if anything less than perfect information is provided. Perfect information includes not only information on the commodity itself, but also information on substitute commodities, how changes in the level of provision of the commodity will affect the respondent etc. In addition, perfect information implies the necessity of provtding the complete psychological context of the economic decision (Fischhoff and Furby, 1988).

Although it may seem that the requirements of perfect information and complete context provide an impossible burden on survey design, the groundwater study described here suggests an approach which may both avoid bias and provide a survey of practical length. This process, summarized here and described in detail in SectIon 3.2 draws much from cognitive survey design. First, a perfect information, complete context instrument is designed. Much of the information in the survey ideally comes from experts who provide a range of scenarios for valuation reflecting technical uncertainties. This instrument, while infeasible for field use (potentially, containing as much as 30 to 40 pages of material), can be used in pretesting where subjects are patd to “become experts.” Both think-aloud verbal protocols and retrospective reports (wherein subjects speak continuously into a tape recorder while answering the surveyor discussing what they were thinking while filling out the survey after the fact) are then utilized to identify problems with scenario rejection and to provide insight into critical infromation problems (i.e., areas where misinformation exists). After redesign based on the verbal protocols and retrospective reports, this full information/complete context instrument is applied in a self administered format to a large enough random sample of individuals that a statistically meaningful estimate of values can be obtained. These respondents then answer a debriefing survey and are asked what information/context was used in constructing their values. Based on these self-reports, little used or unused information/context is removed in redesigning a more compact survey instrument. The redesigned instrument is then re-administered to a new random sample of respondents and the stability of the distribution of values (as compared to the longer original instrument) is examined. Using an approach similar to the idealized description presented above we show that informed/~ context values have a much smaller variance in values (and a substantially lower mean value) than uninformed values.

We also show that, when this process is employed, three alternative approaches for obtaining non-use values for groundwater provide consistent estimates. Such values may be of much greater use for policy making than relying on uninformed or partly informed values obtained from CV studies which do not follow the principle of cognitive survey design. However, there is a philosophical issue of the appropriateness of using informed/full context values for public decisionmaking given that the public may hold uninformed values which are quite different from those obtained using this approach. but which are likely to be reflected in the political process

Other than the central issue of information and context in survey design three additional sources of hypothetical bias, which we define as the difference between the distribution of hypothetical bids obtained from a survey and the distribution of bids that would obtain in a real world incentive-compatible market setting, are discussed in this chapter. These are: (1) embedding (2) large positive outlier bids: and (3) refusals to bid. We will summarize what is known about these possible sources of hypothetical bias on the basis of our two prior methodological studies which we conducted to explore the issue of bias as well as from the results of this study. The first of these uses the Denver air quality problem as the commodity to be valued (Schulze, et al., 1990). This study forms the basis for the second study of U.S. east coast visibility values (McClelland, et al. 1991).

The commodity chosen for the first methodological study, air quality in the Denver metropolitan area, has three features which make it appropriate for exploring sources of error. First, a careful psychological study of how residents perceive air pollution in the region is available (Stewart et. al. 1983, 1984). Second. one of the primary features of Denver's air pollution problem, the "Brown Cloud," is that it obscures views of both the center dty skyline and of the Colorado Front Range and is visible throughout the city. Thus, air pollution has relatively little effect on property value markets, so residents have had little or no market experience with the commodity. Third, a high level of awareness of the problem and a community consensus that something must be done has been achieved in the region. For example, the Chamber of Commerce has strongly supported new proposed air pollution controls and innovative measures such as use of oxygenated fuels that have receied wide public support. Although residents have had little or no market experience with the commodity, most have at least thought about the problem. Our choice of commodity can thus be seen as an attempt to examine hypothetical bias by moving away from market experience while still retaining a commodity for which the public has a clear sense of both the nature and importance of the commodity itself. The eastern (U.S.) visibility study then attempts to resolve a number of serious problems which arose in an earlier study (Tolley et al., 1985).

The chapter is organized as follows: SectIon 3.2 summarizes our research tidings on the role of information and context. Sections 3.3, 3.4 and 3.5 describe our evidence on embedding large outlier bids, and scenario rejection.

3.2 The Role of Information and Context In Cognitive Survey Design

3.2.1 Background

Although, in developing the CVM, economists approached survey design as relative neophytes, two principles rapidly became established. These were: (1) that the commodity to be valued must be well defined (e.g., through use of photographs, maps. detailed descriptions of impacts, etc.), and (2) that a realistic payment vehicle (e.g., an entrance fee) must be used so that respondents would consider the hypothetical situation as a transaction rather than as a charitable donation (see Randall, Ives, Eastman, 1974: and Schulze, d'Arge and Brookshire, 1981, for early statements of these principles, which were later reinforced in Cummings, Brookshire and Schulze, 1988, and Mitchell and Carson. 1989).

Tests of the reliability of the CVM in measuring use values such as those conducted by Bishop and Heberlein (1978) who compared contingent values for goose hunting permits to actual transactions in a field experixnen~

BrookShire et. al. (1982) who compared contingent values for Los Angeles air quality to those obtained in a hedonic study of property values and Smith, et al. (1986) who compared contingent values for water quality along the Monongahela River With values obtained using the travel cost method gave researchers considerable confidence in the CVM when the two design principles noted above were carefully employed.

However, early application of the CVM in measuring non-use values gave researchers considerable pause. For example, Schulze et.al. (1983) obtained very large values for preserving visibility at the Grand Canyon. Concerned about the size of the values, they cautioned: 'To our knowledge. this is the first study attempting to estimate existence values per se. Thus, the methodology used in this study should be viewed as experimental." Cummings, Brookshire and Schulze (1986) conclude in their assessment of the CVM that the method might not be reliable for measuring unfamiliar commodities such as non-use values. They argued that the apparent reliability of the CVM shown for use values resulted from the fact that respondents had actual choice experiences with respect to the commodity and its value to them (e.g., whether to live in a polluted area of Los Angeles or to pay a higher price for a home in an area of clean air).

To remedy the familiarity problem for "exotic"[2] or unfamiliar commodities, Mitchell and Carson (1989) and Fischhoff and Furby (1988) as well as other researchers suggested that much more context was needed in survey instruments so that respondents would actually value what the survey researcher intended the respondents to value. Fischhoff and Furby (1988) provided convincing examples of how citizens might interpret survey

[2]The term "exotic" was suggested by Kahneman and Knetsch (1992).

questions in ways never imagined and how respondents might employ prior beliefs in constructing values inconsistent with those assumed by the researcher.

Motivated by these arguments we began a program of research at the University of Colorado funded by USEPA to explore the effect of information and context on survey values. Two of these studies are relevant to this discussion. The first examined eight alternative survey designs which varied both the amount of information and the context presented in the survey instruments for a familiar commodity. Denver's "Brown Cloud." The use values obtained in this study were quite robust to variation in survey design. Even given the careful attention paid to defining precisely the proposed improvement in air quality in the study and the plausibility of the payment vehicle (in fact higher gasoline prices did later result from mandated use of oxygenated fuels). the stability of values was surprising. The Eastern Visibility study reinforced these conclusions. The aim of our current study is to estimate non-use values for groundwater cleanup. This commodity, of great interest to USEPA, also appeared to be ideal for a methodology study since in early development work undertaken for USEPA by Mitchell and Carson (1989) it was apparent that (1) people were generally poorly informed about groundwater contamination and (2) people resisted the non-use scenario used for valuation in which groundwater was to be preserved but never used. In other words the scenario was rejected by respondents. Delighted with our exotic commodity, groundwater cleanup, our strategy was to apply two new tools in designing the survey instrument.

First, in our work on the "Brown Cloud," we collaborated with Paul Slovic, Sarah Lichtenstein and Robin Gregory (see Irwin, Slovic, Lichtenstein and McClelland, in press) who argued persuasively that, when faced with an unfamiliar commodity, respondents must construct a value rather than relying on some pre-existing value to which they could refer (see Gregory, Lichtenstein and Slovic, 1992). Clearly, given the lack of information demonstrated by respondents in earlier work on groundwater values, informed values would have to be constructed by our respondents based on the information and context provided in the survey instrument.

Second, a revolution has been underway in survey design motivated by the discovery made through the use of verbal protocols (See Ericsson and Simon, 1984, for a description of use of verbal protocols) that seemingly clear questions are interpreted in surprising ways by respondents (at least surprising to those who designed the survey). Application of the new methods of cognitive survey design would provide insights hitherto obtained only with difficulty through extensive use of focus groups or individual debriefings (see Jabine et al., 1984, Cannell et al., 1989, and Willis et al., 1991, for discussions of cognitive survey design).

The remainder of this section will summarize the initial survey design developed for groundwater values, testing with verbal protocols and retrospective reports and final design based on self-administered survey samples.

3.2.2 Design of a Perfect Informatin/Complete Context Survey Instrument

Freed from the usual length constraints imposed by designing a survey we pursued the goals of providing perfect information and complete context. The resulting pre-test instrument (described in detail in Chapter IV) was 24 single spaced pages in length and asked respondents to evaluate a completely hypothetical situation of living in a community whose own public landfill had polluted its own groundwater. The objective of the survey was to obtain use and non-use values for decontaminating the groundwater. The instrument was organized as follows: (1) Respondents were educated about groundwater - how fast it moves (very slowly, 100's of feet per year) and how groundwater contamination occurs (a diagram was used). (2) A risk ladder was presented showing relative and absolute risk of drinking the contaminated groundwater. (3) Respondents were asked how they would adjust to a 50% water shortage assuming their groundwater source could not be used as a result of the contamination. (4) A willingness to pay was obtained for buying supplemental temporary piped in water for a one year period using a temporary surcharge on the monthly water bill as the vehicle. (5) In-home water purification was described and costs presented before asking respondents If they would choose this approach. (6) To provide for future generations, an alternative surcharge was proposed to the water bill; money collected would be Invested for 50 years in a trust fund and guaranteed to be made available to future generations to solve their future water availability problems (subjects were informed that $1 invested for 50 years would yield $100 at a 10% interest rate). This was an attempt both to inform respondents about discounting and to obtain a direct measure of bequest values. (7) Public water treatment was described in which a plant would be built to treat water as needed for current use: a value was obtained through a water bill surcharge. (8) Complete groundwater treatment was described in which contaminated groundwater is pumped, cleaned and re-infected so that present and future generations are assured of the availability of clean groundwater. Again, a water bill surcharge was utilized to collect the Willingness to pay. (9) For the final value in (8) respondents were asked to state if their dollar value was just for cleaning up groundwater or if any part of it was for a list of good causes. If they indicated that their stated value was somewhat for other causes they were asked what percent of their bid was just for groundwater cleanup. Respondents were then asked how much of the amount just for groundwater cleanup, as a percent, was for use value and how much for several categories of non-use values. These questions test for any embedding problem and allow a correction to be made (see Section 3.3 for a complete discussion of embedding). (10) Socioeconomic questions completed the survey.

Each of the valuation questions included considerable detail on how programs would be funded and what the money would be used for as well as assurances as to what would be accomplished with the money. Many of the scenarios (3-7 above) represent substitute public or private actions as alternatives for complete groundwater cleanup as presented in (8). Presentation of substitutes is critically important for constructing the value of complete groundwater cleanup. According to utility theory, lack of a substitute will increase the value of a commodity; respondents may be unaware of or fail to think of substitutes for an unfamiliar commodity. Fischhoff and Furby also made the related point that if information or context is not provided, respondents will make default assumptions in constructing values. For groundwater a relevant default scenario might be that people at some future time might have no water to drink unless complete cleanup occurred. Obviously, substitutes such as importing water, surface treatment, etc., demonstrate the unlikely nature of this potential default assumption.

The information used in designing the survey was developed for us by staff members of the Office of Solid Waste of USEPA who served in effect as our “panel of experts.” Their technical statements were reworded to be more understandable to the lay person. We now turn to the results of the verbal protocols and retrospective reports.

3.2.3 Verbal Protocols and Retrospective Reports

Many survey design problems can be uncovered rapidly with complete documentation through the use of verbal protocols and retrospective reports. Randomly chosen adult subjects from a nearby (non-university) community spoke continuously into a tape recorder as they completed the survey and responded to additional predetermined prompts from the monitor. These sessions lasted about two hours each. We focus on two design issues: (1) the role of information and (2) rejection of the context provided for a valuation question, a phenomenon which has been labeled scenario rejection which is discussed more fully in Section 3.5 in terms of the impact of scenario rejection on data analysis (a selection problem arises).

The response to the groundwater information. especially the slow rate at which groundwater moves, is summarized in the following statements drawn from the transcripts of the verbal protocols and retrospective reports from six different individuals: (1) "Probably not very fast. Probably depends on where the water comes from 2 feet/second. 2 hours . . ..Maybe 10 miles." (2) "Very surprised [to learn groundwater speed]. I didn't realize that." (3) "Extremely surprised. Think about a potted plant, pour it In and it runs out immediately." (4) "30 miles an hour/ tops. It shoots out of there pretty quick . . . It's got to be quicker than people would guess. Not nearly as quick as a river but I know it flows out of the fields." (5) "It seems like it could go through a mile in a matter of an hour if the water is moving that fast....I would have to guess on something that is fairly shallow like a city water supply it could go at the most maybe 10 or 15 miles.” (6) “Not surprised. I thought it moved slower. I had a geology class recently and that was part of the aquifer and aquafluids so I was aware of how groundwater works and functions.”

The prevailing view that groundwater moves very quickly translated for some respondents into a default assumption that contamination would quickly spread over a very large area, implying larger values than the actual situation would suggest. Interestingly however, although many people had a mental model of how groundwater ‘Works” which differs from that of scientists, they apparently recognized that their model was not factually based and readily adopted the model presented in the groundwater Information section of the survey instrument.

In strong contrast to the willingness of respondents to adopt the groundwater mental model presented in the survey, respondents completely rejected the notion of a fund for future use which would accumulate Interest for 50 years to provide for future generations. Their mental model of such a trust fired differed dramatically from that presented in the survey as shown in the following statements taken from eight ***of the verbal*** protocol and retrospective report transcripts: (1) “No. Just In the sense that I don’t know if...I don’t know in a sense that it would be them. They might spend it on something else. Priorities get mixed up.” (2) “Well, again, when are they going to dip into it to use it.... Local government and unions, people want to dip into this fund that sits there to use it and will make it up later and whether or not that happens is...we sure hope so but to take it in and say it cannot be touched and we are going to let it grow for x amount of years you have to trust that that is going to happen.” (3) “I think it’s a crock...It’s like freezing your body to see if there is something in the future to handle it. I’m not a big believer in that." (4) "I don't lend much credence to guarantees through government systems or whoever Is handling the water. If they could give some feedback on what money they received and what sort of use the money is going towards I would be a lot more satisfied. Until then I would be willing to risk only a bit until we find out what will happen with that." (5) "I'd like to believe it, but when they start talking about the S&L scandal. I don't know." (6) [worth of $1 in bank for 50 years] 'probably 10 cents." (7) "I don't think it would be there the way my bank has service charges. They'd take it. In 50 years, I should know, I'd guess $25." (8) "$1OO for $1 after 50 years? I don't really believe that."

None of the other valuation scenarios provoked this sort of negative . reaction. Respondents found the context of this bequest value question unacceptable and many bid zero dollars even though they indicated elsewhere that they were concerned about preserving groundwater for future generations. Respondents also showed a strong preference for cleaning up groundwater now rather than providing monetary compensation - suggesting paternalistic preferences. Scenario rejection can mislead researchers into concluding that people have no value when instead a design problem has occurred. Unfortunately. changes in "context" which supposedly show the unreliability of the CVM can be unintentionally manufactured by comparing two contexts for the same value, one of which is rejected, and one of which is accepted by respondents. The rejected scenario produces many zero values. drastically lowering the mean, while the accepted scenario provides an actual estimate of the underlying value.

3.2.4 Self-Administered Pretests

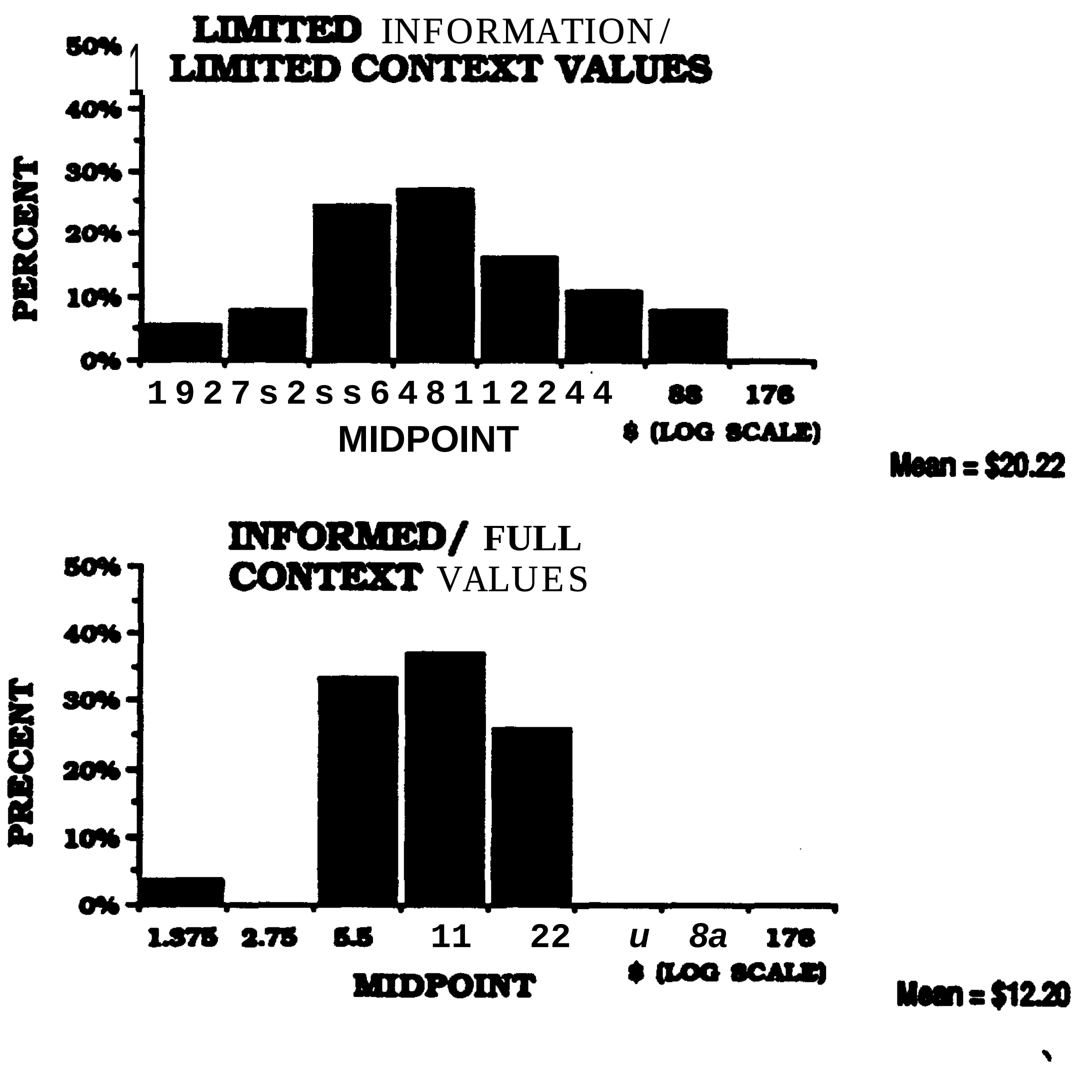
Following the verbal protocols and retrospective reports, two groups of about 40 subjects were randomly chosen from the Denver metropolitan area and brought to a msrket research center (this work is described in detail in Chapter IV). Group 1 was presented only with a description of the physical situation and then directly asked the valuation question on complete groundwater treatment. Thus, the material described in Section 3.2.2 as steps (1) - (7) was deleted from the survey. In other words, both groundwater information and substitute scenarios were deleted. Group 2 was presented with the full information/complete context survey as described in Section 3.2.2. Figure 3.1 presents the frequency distribution of raw values (unadjusted for embedding) obtained from Group 1 (upper panel) and from Group 2 (bottom panel). Scenario rejectors have been deleted from both groups. Two points should be noted. First, a collapse in the variance of values has occurred in the informed/full context values (lower panel) in comparison to the limited information/limited context values (upper panel). Second, to normalize the appearance of the distributions they have been plotted on a log dollar scale. This suggests that errors in bidding which result from lack of information and context are approximately log normally distributed. In fact, although the Group 1 mean is $20.22. and the Group 2 mean is $12.20, the logarithmic means for the two groups are not statistically different.

This result lends additional support to our contention that value errors are log normally distributed, which we have shown both In laboratory, experimental work and through econometric analysis where regressions employ a Box-Cox transformation of the dependent variable (see Section 3.4

for a discussion of hypothetical error). These Box-Cox regressions support a log normal error distribution for contingent values.

Respondents in the self administered perfect information/full context group were given an additional written debriefing survey which they filled out after completing the original instrument. In this debriefing they were

FIGURE 3.1: WTP FOR COMPLETE GROUNDWATER CLEANUP PRETEST V.



asked if each of the information/context components of the original survey raised. lowered, or had no effect on their value for complete groundwater cleanup. These data were then used to shorten the instrument by eliminating or summarizing less Important components of the information/context provided in the original design. The redesigned survey instrument was twelve pages in length and was re-admfnistered to 117 randomly chosen Denver residents in the market research center (see Chapter V for details of this process). Values remained stable as compared to the initial pre-test and removing the abbreviated information and context provided had a similar impact to that shown in Figure 3.1.

3.2.5 Three Methods of Estimating Non-Use Values for Groundwater

Contingent valuation is the only method now able to measure non-use values. It is possible, however, to design CV studies in which the internal consistency of estimated non-use values can be compared. The national survey valuing groundwater cleanup which resulted from the design process described above included variations of the survey instrument in order to provide three alternate approaches for estimating non-use values. (1) Percent Split Approach: all versions of the survey asked for the value of complete groundwater cleanup and for how respondents' values were divided between categories defined as use and non-use values. (2) Scenario Difference Approach: One version of the survey asked respondents for their value for a public treatment option which would only cleanup water as used and thus mostly excluded values for future generations since they would bear the cost of operating and maintaining the treatment plant. The public treatment option mostly captures use value so the difference between the value for total cleanup and public treatment approximates (but likely underestimates) non-use values. (3) Extrapolation Approach: Another version of the survey asked respondents how much they would value the complete groundwater cleanup if the contamination led to a 10%, 40%, or 70% water shortage. We modeled each individual's three values as a quadratic function of the percent of water shortfall.The intercept of this model predicts value for a no shortage situation, thus estimating non-use value for groundwater cleanup.

The mean non-use values (bequest and existence values combined) are $3.49, $2.81 and $3.54 per household/per month for the percent splits, scenario differences and extrapolation approach, respectively (see Chapter VII). These remarkably similar estimates of non-use value demonstrate that internal consistency can be obtained by the contingent valuation method when the survey instrument is developed using the cognitive survey design process described above.

3.2.6 Final Remarks on Infromation and Context

By accepting the notion that non-use values must usually be constructed by respondents rather than assuming values preexist, several important philosophical questions arise. The political process often considers motives or values of the type economists consider to be measured in dollar estimates of non-use values. When parklands are set aside for the enjoyment of future generations and the preservation of wilderness, bequest and existence motives clearly reside in the minds of both constituents and their representatives. These motives, however, because of lack of choice experience, real world context and information may share many of the characteristics of what we have termed limited information/limited context values. In other words, political preferences themselves may be as incoherent and inconsistent as the contingent values challenged by critics of the CVM.

How might the use of the potentially coherent, consistent values which are created by the process we outlined in the introduction be justified? It has long been recognized that rapid changes In measures of attitudes can occur during a political process. However. as more is revealed about the issues (possibly equivalent to the development of full information/full context), attitudes crystallize, become stable and relatively constant over time (Schuman snd Presser, 1981). We would argue that economic values go through a similar process of crystallization. The appropriate goal, we would argue, for the CVM is to attempt to provide crystallized values for public decisionmaking. We hope to have suggested an unbiased process through which such values might be obtained.

3.3 Embedding

3.3.1 Overview

Kahneman and Knetsch (1992) argue that embedding effects are so severe that the usefulness of the contingent valuation method (CVM) for valuing public goods must be questioned. They conjecture that embedding arises because respondents may be valuing something quite different from the commodity for which the investigator hopes to obtain a willingness to pay (W'I'P). Rather, they argue that respondents offer to pay something because the contribution itself provides a source of moral satisfaction. Thus, a change In the commodity to be valued (e.g., cleaning up all lakes versus some lakes) has little impact on respondents' WTP because WTP is based on the moral satisfaction obtained from the contribution rather than from the utility derived from the commodity itself.

Both the results of the Kahneman and Knetsch study Itself and their interpretation contrast sharply with the accumulated evidence obtained in studies testing the reliability of the CVM for use values (as previously mentioned). In these studies WTP obtained from the CVM was compared to WTP obtained from market data using actual transactions, the travel cost method or the property value method. In all of these studies, the CVM gave WTP similar to that obtained from market based methods. For this and other reasons relating to the design snd statistical analysis employed in the Kahneman and Knetsch study, both Glenn Harrison and V.K. Smith in their comments on the Kahneman and Knetsch paper reject the conclusions of the study.

However, it is our view that embedding is a serious problem for the CVM, especially in measuring non-use values. Thus, it is the purpose of the research reported in this section to provide stronger tests of the embedding phenomenon. It should be noted that many researchers have long recognized the embedding issue especially when non-use values are at issue. For example, Cummings, Brookshire and Schulze (1986) raise concerns similar to Kahneman and Knetsch arguing that familiarity with the good is essential to avoid embedding effects. Mitchell and Carson (1989) call embedding "whole-part-whole bias" and discuss methods for avoiding the problem. Fischhoff and Furby (1988) argue that respondents maybe unable to separate component values from larger more broadly conceptualized values.

In this section, we first review alternative explanations for embedding. We then summarize several studies (including our work on groundwater), which demonstrate the embedding problem in different ways. Finally we attempt to resolve the embedding issue (1) through follow up questions which obtain self reports from respondents on the amount of embedding present in their stated values and (2) through the use of increased market context which helps respondents to view their bids as part of a transaction.

3.3.2 Explanations for Embedding

We begin by describing three examples which characterize the embedding problem. Three theories are described which might explain these examples. First. Kahneman and Knetsch and Cummings, Brookshire and Schulze share the notion that embedding is likely to be more of a problem for exotic or unfamiliar commodities. This may explain why embedding has not appeared In the comparison studies mentioned above (which by necessity deal with familiar public goods). Consider a survey asking for the value of preserving an endangered species of butterfly in the Amazon Rainforest. To illustrate the first type of embedding problem consider the following thought experiment:

Step 1) Group A is asked for the value of preserving just one species of "blue winged" butterfly.
Step 2) Group B is asked for the value of preserving all endangered butterfly species in the Amazon Rainforest.
Result Mean bid for preserving one species - mean bid for preserving all species.

To illustrate the second problem consider the following related example:

Step 1) Ask Group A for the value of preserving one species of "blue winged" butterflies.

Step 2) Ask Group A for the value of preserving one species of "green winged" butterflies.

Result: Mean bid for preserving "blue winged" butterflies >> mean bid for preserving "green winged" butterflies.

Step 3) Reverse order with Group B.

Result: Mean bid for preserving "green winged" butterflies >> mean bid for preserving "blue winged" butterflies.

To illustrate the third problem consider a third related thought experiment:

Step 1) Ask Group A for the value of preserving "blue winged" butterflies.

Step 2) Ask Group B for the value of preserving "green winged butterflies.

Step 3) Ask Group C for the value of preserving all butterflies in the Amazon Rainforest.

Result: Mean bid for preserving "blue winged" plus mean bid for preserving "green winged" > mean bid for preserving all butterfly species in the Amazon Rainforest.

Obviously these three problems are interrelated, but how might we explain such patterns of behavior?

Explanation 1: Moral Satisfaction: If as Kahneman and Knetsch argue, bids are based on the moral satisfaction of giving to a good cause and if this moral satisfaction has rapidly diminishing marginal utility in the size of the gift, then Problem 1 results from the same moral satisfaction being obtained from saving one species as saving many. Problem 2 results from the diminished marginal utility of making a second gift to obtain additional moral satisfaction Problem 3 comes about because each separate Group A. B. and C will bid about the same for obtaining moral satisfaction so the sum of the mean bids from Groups A and B will exceed the mean bid of Group C.

Explanation 2: Independent Valuation and Summation: Hoehn and Randall (1989) have correctly pointed out that if the benefits of providing many public goods are each independently estimated in a partial equilibrium framework and then summed across public goods, an overestimation of the value of provision will result. If one assumes strong income and substitution effects one can use the independent valuation and summation argument to explain the pattern of values described above. By these arguments Problem 1can be explained as follows: Imagine that blue winged and all other Amazon butterflies are viewed as nearly perfect substitutes. In this case the preservation of one species is sufficient and the preservation of one or all has the same value. Problem 2 arises both because, once one species is preserved, given near perfect substitutability, the preservation of a second species has little or no value, and because paying for one species reduces the income available to pay for the next. Problem 3 arises because, again assuming near perfect substitution across butterflies, saving any one species or all species in the Amazon Rainforest has the same value. Summing independent values overestimates the total benefits of preserving all species by ignoring substitution and income effects.

Explanation 3: Mental Models of Joint Products:This third explanation, which we focus on in this sectin, arises from many statements made by subjects participating In (1) focus groups, (2) individual debriefings or retrospective verbal reports obtained after filling out CV instruments or (3) verbal protocols obtained while filling out CV instruments. Many (but not all) of these individuals describe their own view of public goods as originating as joint products. This jointness derives from technological reasons such as: “Butterfly species in the Amazon are becoming extinct because of loss of habitat. The only way to save one species is to save all of them by saving the forest as well." When asked for the value of saving one species, such an individual often "corrects" the foolish question asked by the "dumb" researcher and provides a value for saving the entire forest, i.e., not only providing the value for all butterfly species but also for the entire Amazon Rainforest. These views, called "mental models" by psychologists, are often strongly held and will replace whatever mental model the researcher intended to foist on the respondent. Usually these mental models imply jointness as noted above.

Another frequently occurring mental model relates to the way public goods are actually provided in democratic societies. Many respondents view the connection between taxes and public goods as joint Le., more taxes Implies more public goods of all types. Thus, similar to the arguments of Kahneman and Knetsch, some people value much more than the researcher intends. For example, one respondent explained his bid for a particular environmental improvement as incorporating money for education and other unrelated public services: "I know what happened when gasoline taxes were raised to fix roads in Colorado -- the pothole in front of my house is still not fixed -- but those taxes went into the general fund and you (a University of Colorado, Economics Professor debriefing the respondent) got a salary increase!" This respondent was actually happy to have more money go to eduction and incorporated the value of an expansion of all public services in the bid.

The joint product mental model can explain the three embedding problems noted above as follows: In Problem 1 the bid for one butterfly species is the same as the bid for all species because respondents believe (perhaps correctly) that the only way to save one species is to save the habitat for all species. Thus, Group A bids for saving gabitat which provides the benefits of saving all butterfly species in that habitat. In Problem 2. having been asked to bid to save one species, but in actuality having provided a bid to save all species in the habitat, when asked for additional money to save a second species, respondents bid zero because they have already paid to save the second . In effect they reject the scenario presented by the researchers as unrealistic. Finally, in Problem 3 Groups A. B, and C each provide values for preserving butterfly habitat in the Amazon. Thus, the three values are nearly the same so the sum of the mean values from Groups A and B will exceed the mean value of Group C.

One important qualification needs to be made to these arguments. Not all respondents have the same mental models. In fact, debriefings have demonstrated a wide variety of mental models concerning the financing and technology of provision of environmental commodities. Some respondents will accept the implicit mental model used by the researcher in designing the survey, while others will not. Where mental models imply jointness, embedding problems will result, providing a potential problem for the investigator in interpreting the bids obtained from respondents.

Finally, the mental model interpretation of embedding in no way rules out either the arguments of Kahneman and Knetsch (in that one of the joint outputs of a bid could well be a type of moral satisfaction) or the independent valuation and summation argument of Hoehn and Randall (in that some respondents may not hold a joint product mental model but rather view certain environmental commodities as near perfect substitutes). We now turn to a description of a survey specifically testing this inclusive mental model hypothesis.

3.3.3 The Denver Air Quality Study

Our methodological study of air quality values conducted in the Denver metropolitan area was motivated in great part by a controversy over the reliability of values obtained in a CVM study of air quality by Tolley et al., (1985). In that study, respondents were asked to provide a dollar WTP for visibility improvements. Critical reviews of this study motivated both Fischhoff and Furby (1988) and Mitchell and Carson (1989) to question the ability of respondents to provide a separate visibility value, arguing that many Individuals would include values for health as well. In our Denver study (described in detail in Schulze et al., 1989) we mailed eight different versions of a survey instrument which included a color insert presenting photographs of different local air quality conditions. A 71% overall response rate was obtained with no version receiving less than a 69% response rate. Two versions of the survey instrument tested the notion of mental models presented in the previous section. However, before describing these two versions we need to develop a formal economic model of embedding which results from a joint mental model. This theoretical viewpoint then motivates the design of the survey instruments.

Let:

Q = Air Quality,
V = Visibility,
H = Healthiness of the Air,
G = Other Public Goods,
X = Composite Commodity with a price equal to 1.

and X^0 = Income.

We assume that some respondents have a mental model such that

$$H = a_H Q, \quad V = a_V Q, \text{ and } \quad G = a_G Q.$$

where a_H, a_v, and a_G are fixed positive coefficients. In other words, an improvement in Q also results in improvements in V, H, and G and any improvement in V necessarily implies improvements in Q, H, and G. For such respondents, the compensating variation measure of WTP for an improvement in visibility can be obtained by totally differentiating the constant level of utillty of the consumer,

$$U(V,H,G,X^o\text{-}WTP) = U^o$$

subject to the joint product constraints listed above. The marginal willingness to pay for visibility then takes the form:

$$\left.\frac{\partial WTP}{\partial V}\right|_{U^o} = \& + \left(\frac{a_H U_H}{a_V U_X}\right) + \left(\frac{a_G U_G}{a_V U_X}\right)$$

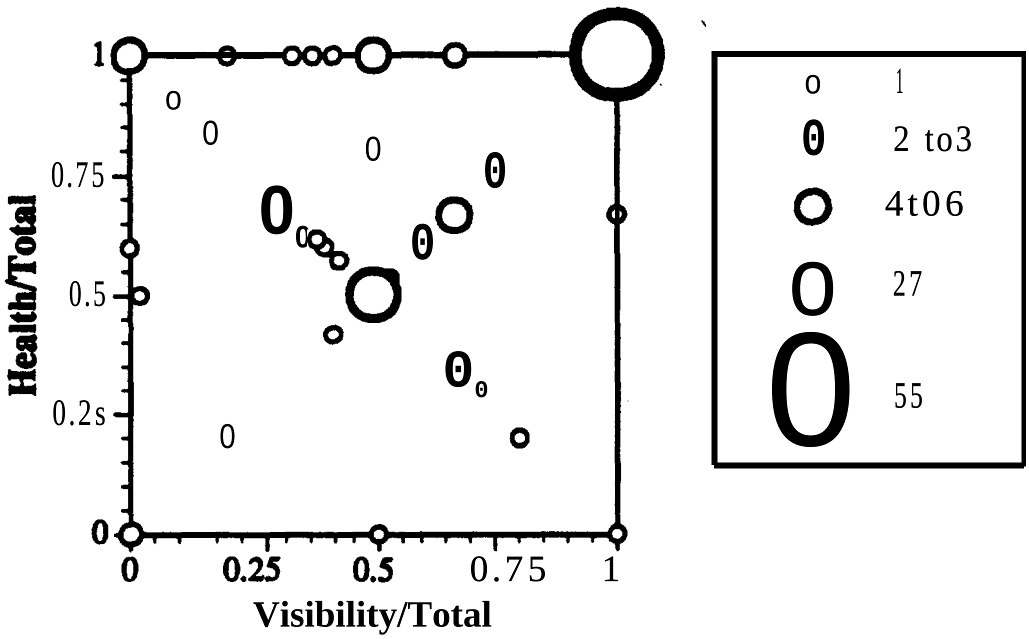
(d) (b) (c)

Thus, if an individual who believes that government services are produced as joint products is asked to provide a bid for a small increase in visibility, the bid will contain not only the marginal Willingness to pay for visibility (term (a) above), but will also contain appropriately proportioned values for related health improvements (term (b) above) and for increases in the provision of other public goods (term (c) above). If an individual does not have such a mental model, i.e., accepts the possibility of only changing health or visibility in response to a particular program. then only term (a) will be present.

We tested this hypothesis in two ways. First, in one survey variant we ask respondents to provide a dollar value for visibility improvement, then a separate dollar value for health improvements, and finally a total bid for the sum of visibility and health improvements for a specific air pollution program. Some people responded with three bids in the following pattern: $50 for visibility, $50 for health, and $100 total indicating that they did not view the proposed program as providing joint products. However. a large number of respondents gave bids in the following pattern, $100 for visibility, $100 for health, $100 total, consistent with the joint product hypothesis. Data from these questions in the Denver study are presented in Figure 3.2. The vertical axis presents the ratio of health improvement bid to total bid for the stated air quality improvement. The horizontal axis shows the ratio of visibility bid to total bid for the stated air quality improvement. The size of the bubbles in the figure (as shown in the key) indicate the number of respondents whose bid pattern corresponds to the point at the center of the bubble.

First, note the clustering of respondents along the diagonal with a slope of -1 (from the upper left to the lower right hand comers of the figure). These individuals follow the first pattern discussed above, e.g.. if .25 of the total bid goes to the visibility bid, .75 goes to the health bid. These Individuals do not show an embedding problem (for the researcher) and represent 36% (49 out of 137) of the sample. Another large group show what Kahneman and Knetsch call “perfect embedding," consistent with the

FIGURE 3.2: ANALYSIS OF EMBEDDING - DENVER AIR QUALITY STUDY



joint product model formalized above. This group consisting of 55 respondents (40% of the total sample) submitted the same bid for visibility, health and total air quality improvement and are located in the upper right hand comer of the figure. Thus, 76% of respondents are consistent With either the hypothesis of no embedding or of perfect embedding. However, the joint product hypothesis can account for other individuals in the sample as well. For example those on the diagonal line with a slope of +1 show a form of partial embedding in which they are unable to disaggregate their values full yinto components. Other points may simply show an ordering effect consistent with the independent valuation and summation argument, i.e., in giving a bid first visibilaty and then for health, when finally coming to the total bid, the respondent may realize that the additive total was more than they wanted to pay.

A second way to examine this issue which encourages consistent answers is to incorporate a follow up question. as we did, in the second version of the Denver Air Quality survey. This version asks respondents only for a total bid, but then asks them to split the bid up into its possible component parts. Thus, a respondent can (as they did on average in the Denver study) plausibly state "my bid was 27% for visibility. 48% for health. and 25% for "other" unspecified values consistent with either preferences constrained or unconstrained by a joint project mental model. Note that those individuals in Version 1 who did not embed (i.e., those in Figure 3.2 who lie along the diagonal with a slope of -1) also favored health over visibility since most responses lie along the diagonal to the upper left in the figure.

In the Denver study no follow up questions asked respondents about the source of values not ascribed to health or visibility. The next section reports on studies exploring this issue.

3.3.4 Studies Seeking Self-Reports of Origins of Embedding

Another early study attempting to analyze and adjust for embedding effects formally was conducted by Chestnut and Rowe (1990), they obtained new estimates of the value of visibility in National Parks using a more sophisticated survey approach (aware of embedding issues) than that of Schulze et. al., (1983). Using follow up questions which followed the valuation question, they estimated that 38% of the stated values were unrelated to the proposed changes in visibility in national parks. What is of specific interest here IS that for the less familiar commodity 'Risibility in national parks," embedding was above the 25% level reported in out study of the very familiar "Brown Cloud" problem in Denver (Schulze, et al. 1989).

A second study to attempt to identify the source of embedding (Rowe et al. 1991) used two different versions of their survey to explore the problem of embedding in WPT values for preventing oil spills off the coast of Washington State. A serious embedding problem was apparent in that many respondents indicated that any program to prevent oil spills was likely to prevent large spills as well as moderate and smaller spills. Thus, a strong tendency to bid to prevent all spills was present. Version 1 asked respondents how much they would pay over the next five years to prevent all spills while Version 2 asked respondents to bid over a five year period to prevent a moderate sized spill. Respondents to both versions were then asked if their value was just for the stated oil spill prevention program or if the bid included values for other environmental and public causes. If they indicated that their bid included values for other environmental or public causes they were asked what percent of their WTP was just for the stated program (either to prevent all oil spills in Version 1 or to prevent moderate sized oil spills in Version 2). In Version 1, only 63.5% of the average bid across respondents was assigned to oil spill prevention. This figure falls to 50.5% for Version 2. Thus, the decreased context and information provided by evaluating only moderate size spills as opposed to evaluating all sizes of spill increased self-reported embedding from 36.5% to 50% of the stated value.

In our groundwater work described in the following chapters we incorporated the "disembedding" question shown in Figure 3.3. In Question 12 respondents are asked if their bid is just for the stated complete groundwater cleanup program or if their stated WTP includes values for a wider range of environmental and/or public causes. This question in effect

FIGURE 3.3: DISEMBEDDING QUESTIONS: GROUNDWATER SURVEY

(Q12 Some people tell us it is difficult to think about paying to reduce just one environmental problem. Would you say that the dollar amount you stated your household would be willing to pay for complete groundwater cleanup (QI 1) is: (Circle number)

1. JUST FOR THE STATED GROUNDWATER PROGRAM (Go to Q 14)

2. SOMEWHAT FOR THE GROUNDWATER PROGRAM AND SOMEWHAT A GENERAL CONTRIBUTION TO ALL ENVIRONMENTAL CAUSES

3. BASICALLY A CONTRIBUTION TO ALL ENVIRONMENTAL OR OTHER WORTHWHILE PUBLIC CAUSES

4. OTHER (Please specify)________________________

Q1 3 About what percent of your dollar amount is <u>just</u> for the stated complete groundwater cleanup program? (Circle percent)

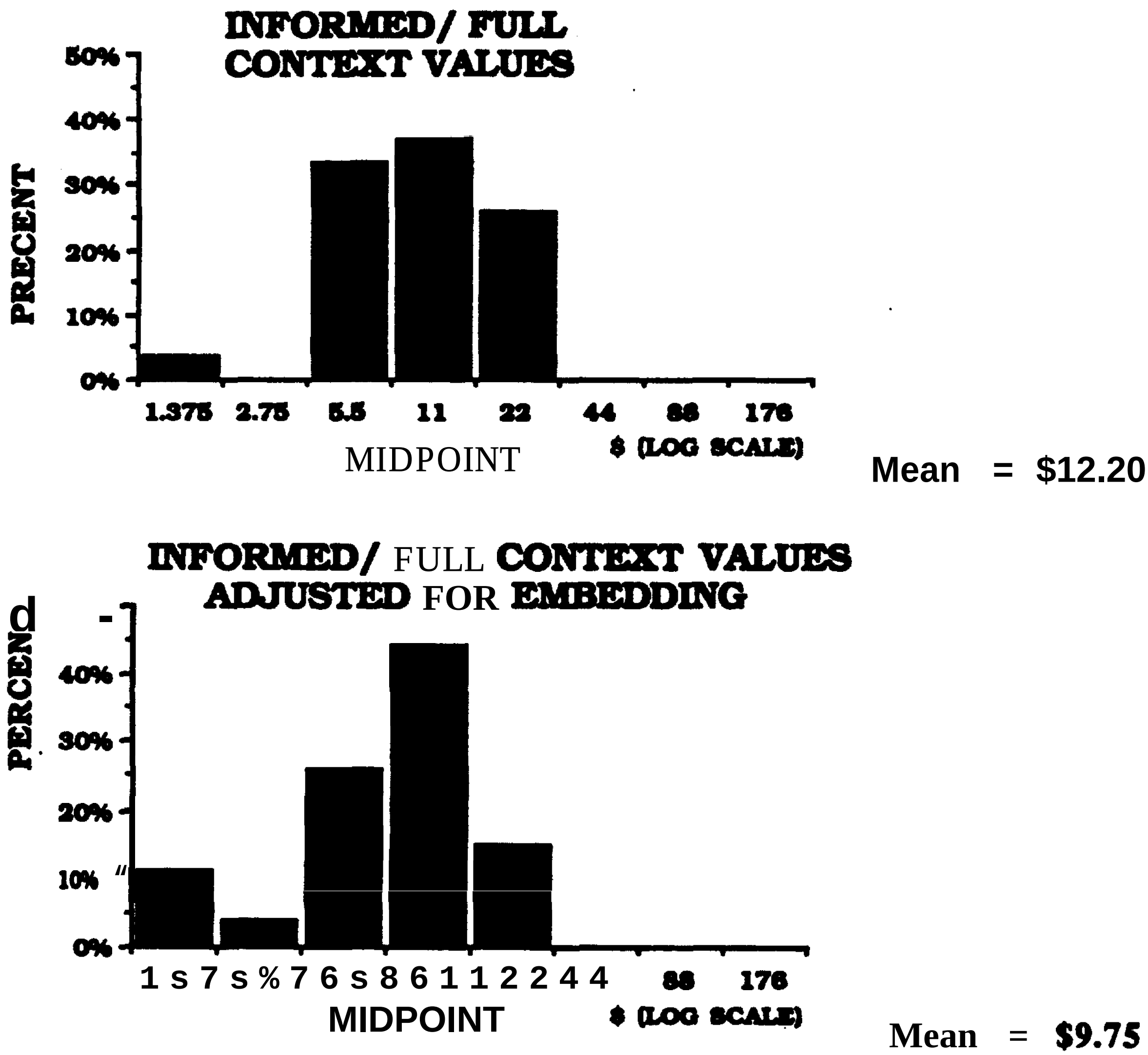
NONE SOME HALF MOST ALL

0% 10% 20% 30% 40% 50% 60% 70?% 80%0 90% 100%

asks "Are you embedding?". If the respondent answers "Yes", Question 13 then asks "How Much?"

For the pretest subjects who were given perfect information and complete context before answering the valuation question, the level of self-reported embedding was 20% of the reported values. Figure 3.4 shows the

FIGURE 3.4: UNADJUSTED WTP AND WTP ADJUSTED FOR SELF-REPORTED EMBEDDING: FULL INFORMATION/FULL CONTEXT SURVEY



frequency distribution of perfect information/complete context bids in the top panel and the frequency distribution of bids which have been individually adjusted for self-reported embedding in the bottom panel. Noting the logarithmic horizontal axis, adjusting for embedding further reduces the right skewness of the bids. The shortened national mail survey for groundwater values retained a nearly identical amount of self-reported embedding of 21.2%, suggesting that retention of appropriate information and context also reduces embedding almost as effectively as the lengthy perfect information / full context pre-test survey.

3.3.5 Conclusions on Embedding

Table 3.1 summarizes the degree of self-reported embedding from the studies discussed above.

Perhaps the most surprising result of these studies is that many respondents unabashedly admit to embedding in a manner consistent with the joint product mental model proposed above. Our evidence is consistent with the psychological notion that people have many different mental models which they use to interpret the world around them. Thus, some respondents do not show an embedding phenomenon at all. It is our view that techniques for resolving the jointness of values must be incorporated into survey design. One successful approach is to ask respondents to partition a total value while another is to increase information and context about the commodity to be valued. We employ both approaches in valuing groundwater cleanup.

TABLE 3.1: SELF-REPORTED EMBEDDING IN CVM STUDIES

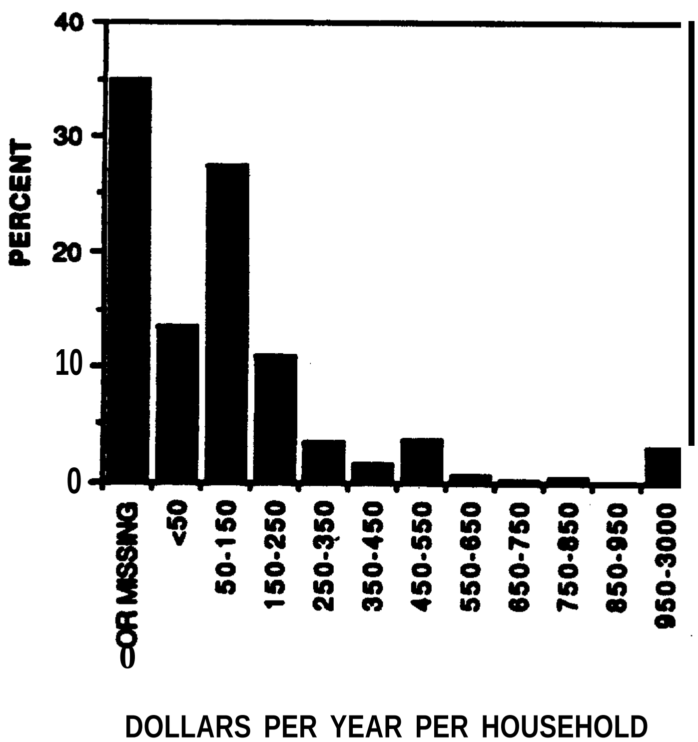
STUDY	COMMODITY	PERCENT EMBEDDING
Chestnut and Rowe (1990)	Visibility in National Parks	38.0%
Rowe et. al. (1991) Medium Size Oil Spill Version	Preventing Death of Seabirds	50.0%
All Oil Spills Version		36.5%
Groundwater Full Information/Full Context	Complete Groundwater cleanup	20.0%
Relevant Information/ Mail Survey		21.2%

3.4 Hypothetical Error

Survey values obtained in the field have tended to be bimodally distributed with a large number of missing or zero bids and an upper mode which is skewed. showing a thick tail of large bids. For example, figure 3.5 shows the distribution of bids from the Denver air quality study. Researchers have viewed both the large number of bid refusals and the very high bids with skepticism. Fortunately, laboratory experiments and more recently our exploration of the role of information and context presented in Section 9.2 above, have shed considerable light on the problem of large bids which suggest a stralghtforward econometric approach. Refusals to bid (mostly in the form of missing bids) can create a selection bias problem in estimating the true value of positive bids, an issue we discuss in the next section.

Researchers first turned to laboratory economics experiments to understand the source of large hypothetical bids obtained in CVM studies. These laboratory experiments typically place subjects in an unfamiliar environment (either with respect to the commodity. the market, or both) and compare an initial hypothetical response to actual laboratory market

FIGURE 3.5: WTP FREQUENCIES (IN DOLLARS) - DENVER AIR QUALITY STUDY



responses where repeated trials are used to provide market experience. We briefly summarize what has been learned from such experiments and, drawing on these experiments, propose both a specific model of hypothetical error (a form of measurement error) and suggest an econometric approach for analysis of contingent values which may reduce such errors.

Results from laboratory experiments show a consistent and striking pattern. Hypothetical bids obtained from subjects for a commodity show an increased variance relative to bids obtained in a laboratory market. Further. increasing market experience (repeated rounds in a particular auction institution) and increasing incentives (increased payoffs for participation in a particular market institution) both tend to reduce variance in bidding.

The first experiment to compare hypothetical bids to auction behavior, undertaken by Coursey, Hovis and Schulze (1987), used a bitter tasting liquid, sucrose octa acetate, which was unfamiliar to subjects as the commodity. Subjects were first given a careful description of the commodity and then were asked how much they would pay to avoid a taste experience. Second, subjects were allowed to taste the liquid prior to being asked again for their willingness to pay (WTP). In this second stage subjects were familiar With the commodity but had no market experience. Third, subjects participated in a competitive auction submitting bids to avoid the commodity. Mean bids (variance) were as follows: Hypothetical with no experience $2.80 ($15.80): hypothetical with experience with the commodity $2.27 ($5.08): and actual auction bids with market experience $1.95 ($5.23). Note, the variance is much greater for the Inexperienced hypothetical bids. However it appears that the decrease in variance was associated with expedience with the commodity rather than With experience with the market institution.

Other recent experiments that allowed more, rounds of actual market experience than the Coursey, Hovis and Schulze experiment show a continued decline in bidding variance both with market experience and reward size (see Irwin, McClelland and Schulze, 1992 and Cox. Smith and Walker, 1989). Figure 3.6, taken from Irwin, McClelland and Schulze, shows how the increased variance in hypothetical bidding can bias estimates of actual behavior. The top panel of Figure 3.6 shows a skewed hypothetical distribution relative to the actual bidding distribution shown in the bottom panel. The extended right hand tail is the source of a large upward bias in the mean hypothetical bid as compared to the mean of actual bids. This source of error dominates the results of this experiment.

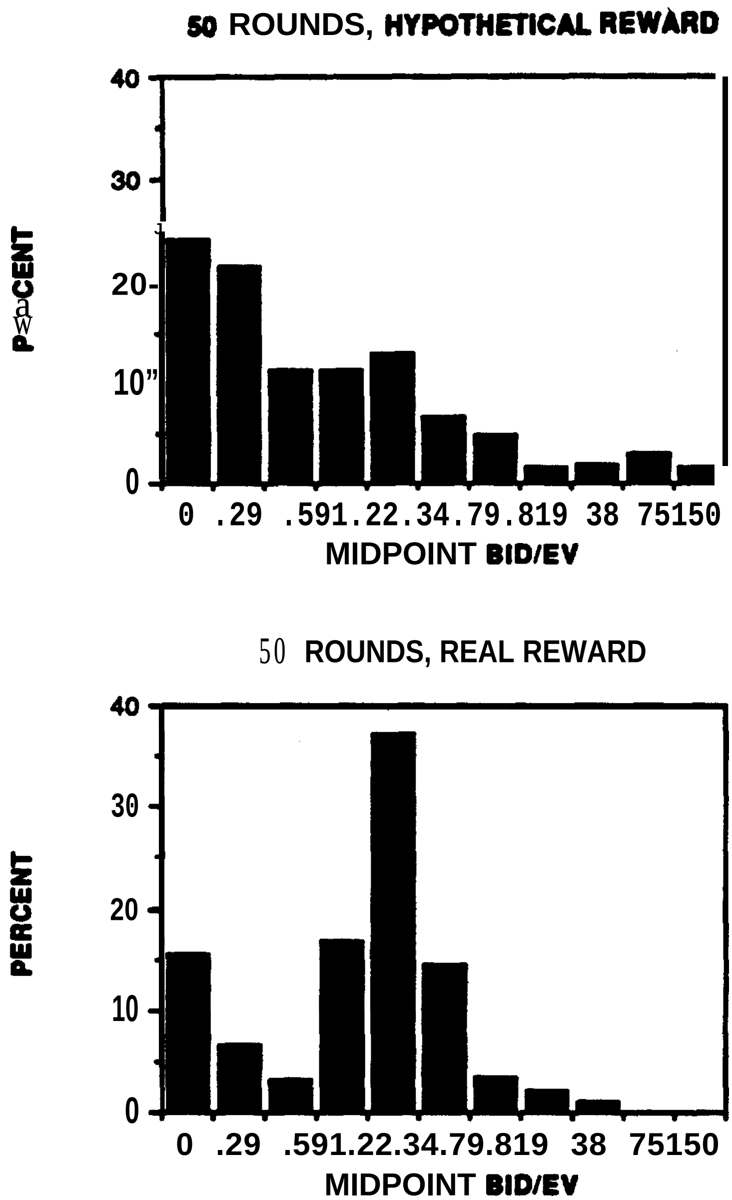
Given the experimental evidence summarized above and our earlier demonstration that provision of information and context appear to reduce the variance in a log normal distribution of hypothetical errors. what model can be used to explain hypothetical bias that might result in field surveys from a lack of information, context and experience? Assume for simplicity that individuals have a true willingness to pay, W. However,the bid they reveal in response to a hypothetical question about willingness to pay is B. The laboratory data in Figure 3.6 suggests that the bids are highly skewed so, for example, a model for the revealed bid could be

$$(1) \qquad \ln B = \ln W + \varepsilon,$$

where ε is measurement error. assumed to be distributed ε - $N(0, \sigma_1^2)$.

If we replace 1nW with an econometric model

FIGURE 3.6: EXPERIMENTAL VALUES (Source: Irwin, McClelland Schulze (1992)



(2) $1nM = \Sigma\beta_i X_i, + V$

where Xi are explanatory variables, there is now an additional source of error, v due to the econometric model. Substituting equation 2 into equation 1 gives:

(3) $\ln B = \Sigma\beta_i X_i, + (\varepsilon + \nu)\,.$

Assume v - N(O, σ_v^2). If there were no measurement error, the predicted mean bid using the formula

(4) $\hat{B} = e^{\Sigma\hat{\beta}_i X} + 1/20V2$

would be a consistent estimate of the true mean WTP. With both errors present,

(5) $\hat{B} = e^{\Sigma\hat{\beta}_i X_i + 1/2\,\hat{\sigma}^2}$

where $\sigma^2 = V(\varepsilon + v)$. This is an upper bound estimate which will give a predicted mean approximately equal to the raw mean of the contingent value bids used in the analysis. It is Impossible to know a *priori* how much of the errors is model error, and how much is measurement error. But from laboratory experiments and our examinatino of the Impact of information and context we know that skewed measurement error is likely to be present, which implies that the raw mean of the CVM bids will overestimate true values. If there is no model or measurement error, the predicted mean bid given by

$$(6) \qquad \hat{B} = e^{\hat{\beta}_i X_i}$$

is a consistent estimate of the true mean WTP. If we assume ε and v are uncorrelated. then

$$(7) \qquad e^{\Sigma\hat{\beta}_i X_i} \leq e^{\Sigma\hat{\beta}_i X_i + 1/2\, \sigma_v^2} \leq e^{\Sigma\hat{\beta}_i X_i + 1/2\, \sigma 2}$$

and we can bracket the appropriate bid with a lower and upper bound.

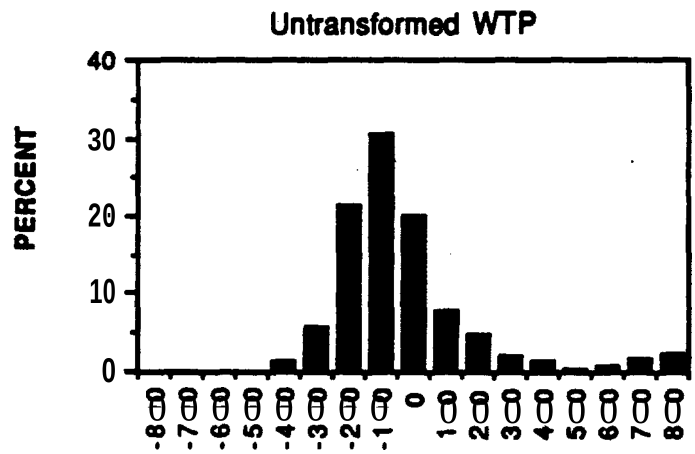
We propose use of a more general transformation than the log transformation to account for skewed measurement error. This transformation is the Box-Cox, $(B^a - 1)/a$, where a is determined to normalize the error distribution in regression analysis (Box and Cox, 1964). Predicted bids from the regression analysis should then be used as a lower bound for policy analysis. Note that this transformation incorporates both the linear (a = 1) and natural logarithm (a = 0) transformations as possibilities.

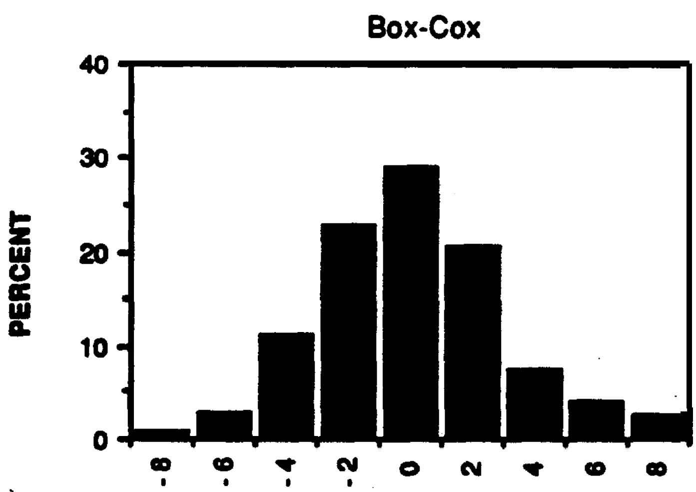
Use of this procedure has several advantages. In the past large suspect bids obtained in the CVM have been removed through timming e.g., Desvousges, Smith and Fisher, 1987). Trrimming procedures remove large outliers which deviate from an estimated linear regression model by exceeding some predetermined statistical threshold. However, in the situation where the bid distribution shows a thick upper tail, the mean of predicted bids falls as that threshold is lowered, making final estimated values dependent on the threshold chosen. If skewed measurement error is present, the procedure we propose will also lower mean values if bids generated by the estimated regression equation are used in calculating the mean. However, the reduction In predicted mean bid will be determined by the estimated value of α, the Box-Cox parameter, so as to make the distribution of residuals as normal as possible. If measurement error dominates the residual then it is obviously desirable to use an estimating procedure which does not bias the estimated coefficients through a skewed error distribution. Predicted values from this estimated equation can then be used to calculate mean or total willingness to pay.

In the Denver air quality study, the Box-Cox procedure was employed and gave an estimated coefficient of a = 0.12. The mean of predicted bids was a little over half of the raw mean of the bids (about $118/per per household vs. $202/year per household), varying somewhat depending on specification of the regression equations and the treatment of the selection bias issue. The frequency distribution of residuals from a linear regression for comparison to those from the Box-Cox regression explaining bids is shown in Figure 3.7. (Nearly identical estimates of a were obtained in the Eastern U.S. Visibility Study and in our work on groundwater). Obviously substantial skew is present in the linear regression and the Box-Cox procedure produces an essentially normal distribution of residuals. Thus, the procedure developed above can be defended on purely econometric grounds as an appropriate method for dealing with large outliers which would otherwise bias CVM studies.

However. it should be noted that the econometric model used to predict bids in the Box-Cox regression in the case of the Denver study'had a fairly low explanatory power since the R^2 was about .13. Thus, the predicted bids might underestimate actual values since a substantial amount of model error may be present. Additional variables were added to the groundwater survey to help explain values. Although the Box-Cox coefficient was similar to our earlier results, the R^2 in this case rose to .30.

FIGURE 3.7: RESIDUALS FOR WTP REGRESSIONS - DENVER AIR QUALITY STUDY





3.5 Scenario Rejection

A second problem in the interpretation and analysis of contingent values is the presence of missing bids or protest zero bids when respondents are asked for willingness to pay (WTP). When pretesting survey instruments, researchers have often found that failures to bid or zero bids are not associated with a zero value to the respondent. Four reasons have been identified for such behavior through verbal protocols and debriefing questions. First, the respondent may not feel responsible for the problem and as a result conceals their value. The mental process leading a respondent to conceal WTP as revealed by debriefing in the Denver air pollution study was as follows: “Cleaner air is very valuable to me so I would have to pay a lot to reflect that value: but, fortunately, air pollution is not my fault so I should not have to pay. So, I just will not answer the question since it does not apply to me.”

A second reason for scenario rejection is that the respondent prefers another technical solution for cleaning up the environment than that presented in the scenario to be valued. Thus, for example, in our groundwater work described herein some individuals bid zero for complete groundwater cleanup because they preferred just treating contaminated water as it was pumped up for use. In effect, although they had a use value which was provided by complete cleanup, they refused to reveal that value with a bid for complete cleanup because they did not wish to endorse that technical approach. This type of scenario rejection is especially common when using the referendum format (see Chapter IV).

A third reason for scenario rejection is that the respondent may not believe that the objectives of the scenario presented for valuation will be achieved by the scenario. Our previous example of “a fund for future use” to allow future generations to cleanup contaminated groundwater was, as noted in Section 3.2, rejected by respondents because, in great part, they did not trust the government to maintain such a fund for 50 years or wanted cleanup to occur immediately.

Finally, the fourth reason for scenario rejection (actually a false zero bid) is the tendency of respondents to either round off their value estimates to zero or refuse to bid if their values are small or if the effort of bidding is high. The cognitive effort of estimating a 50¢ bid is unlikely to be worthwhile to the respondent to a CV survey. Similarly, respondents who are asked to state a value may imagine that a very precise number is required such as $28.32 and feel unable to come up with the anticipated level of precision and so refuse to bid. One solution to this problem is to provide approximate values such as $0, $1, $5, $10 and so on so as to indicate the desired level of precision.

As argued by Smith and Desvousges (1987), the absence of bids from such respondents who reject the scenario results in a potential selection bias problem since as many as 35% of respondents may refuse to provide credible values as they did in our Denver study. In estimating a regression model for those respondents who do provide a WTP value, selection bias must be accounted for to obtain unbiased coefficients (Heckman. 1979). However, in the Denver air pollution study we found that correcting for selection bias requires that the first stage probit equation must include an appropriate identifiers. Since we did not such variables available, we could not obtain reasonable predictions for missing bids. In other words, appropriate variables explaining whether a respondent gave a bid must be included in the probit equation, but excluded from or be insignificant in the equation explaining WTP. We had no such variables in the Denver study but, based on debriefing questions included in the survey, determined that acceptance of responsibility (as opposed to the presence of benefits) for paying for air pollution cleanup was one missing factor. Thus, In the Eastern visibility survey instruments we included a number of variables attempting to measure this factor. Responsibility variables were highly significant in the probit equation explaining “missing” WTP responses and these same variables were non-significant in the estimated willing to pay equation. With a properly identified model, selection bias was not present and predicted bids for missing respondents were $49 per household per year as opposed to predicted bids for those who gave values of $132. Note that excluding missing values would lead to an overestimate of willingness to pay for the population as a whole. Based on this study it would be more accurate to assign a zero value to those with missing values rather than assign the mean value of those who did respond with a positive bid.

Another approach for avoiding a selection bias problem is to design the survey instrument itself to avoid scenario rejection. This approach was pursued in the groundwater work reported here with considerable success in that the number of bid refusals fell to 5% of the sample. We reduced scenario rejection both by dropping the referendum format (although our initial pretesting used this approach) and by presenting subjects with approximate values to choose from. These values were drawn from an approximately logarithmic scale so as to avoid truncating the distribution of values. Obviously, a selection model was unnecessary in this case for scenario rejection. However. the question of the appropriate value to be used for survey non-respondents remains. Based on our earlier work on Eastern visibility values where item non-respondents had low values, we suggest a zero value be ascribed to survey non-respondents as a conservative approach.

3.6 Implications for Applications of the CVM to Non-Use Values

The objective of the research described above was to refine our understanding of the CVM by examining potential sources of error by first using a relatively well understood commodity, air pollution and then proceeding to attempt to estimate non-use values of a less familiar commodity. What are the implications of this research for the valuation of non-use values?

First, the more exotic the commodity. the larger the measurement error is likely to be. In other words in valuing very unfamiliar commodities, people are likely to make larger errors in predicting what they would actually pay. If these errors are positively skewed, a procedure such as the Box-Cox method proposed here will be essential to avoid overestimating values.

Second, the more unfamiliar and difficult the commodity is for people to value, the more likely it is that people will be unable to come up with a value. These missing responses may create a selection bias problem since, as we have shown, such respondents may have lower' values than respondents who do provide values. However, changes in survey design can greatly reduce scenario rejection. especially using the cognitive survey design approach.

Third, embedding problems are likely to be very severe for issues such as species preservation. Many people will find it impossible to value saving one species of butterfly without saving all species in the forest, as well as saving the particular forest, if not all forests! We have shown that many people do view environmental preservation as a joint product phenomenon which requires careful attention by researchers. A problem occurs when researchers ask Group A for the value of one species of butterfly, Group B for the value of another species and sum the values. If both Groups A and B were in fact valuing both species plus the value of preserving the whole forest not only are butterfly values double counted but the value of preserving the entire forest is included as well. Careful pretesting can reveal such problems and appropriate debriefing questions can be incorporated into surveys to find out what values respondents have included in their answers.

Finally, as the commodity becomes more exotic, the role of survey information and context increases dramatically. If respondents have no a ***priori*** idea as to the nature and characteristics of the commodity, the survey context itself must totally define the parameters used by the respondent to construct a value. Cognitive survey design allows an understanding of what information is necessary for respondents to construct meaningful values. Furthermore, additional information and context appear to reduce the amount of self-reported embedding, as well as increasing the likelihood of respondents providing a bid.

Chapter IV

Perfect Information/Full Context Survey Instrument Design and Testing

4.1 Description of Pre-Test Surveys

4.1.1 Survey Design

The main goal in designing the pretest surveys was to provide perfect information and full context for valuation of a plausible groundwater cleanup scenario. Both a perfect information/full context version and a shorter and simpler limited information/Mmited context version were tested using (1) verbal protocols and retrospective reports and (2) two samples of self-administered surveys with a written self-administered debriefing survey. We also report statistical tests which assess the effect of information context. The two surveys which were administered during preliminary pretesting are presented in Appendixes A and B.

There are five different conceptual sections to the pretest surveys, each of which is described In some detail below.

Section 1 provides a short introduction designed to present the issue of groundwater contamination and ask a few easy preliminary questions which assess subjects' general awareness of groundwater issues.

Section 2 presents the detailed information about groundwater issues, hazards, and remediation. It begins with a set of questions asking about subjects' knowledge of and experience with groundwater contamination in their own area, interspersed with short sections of text which give various facts and information about groundwater, A diagram showing schematically how leachate from landfill might enter the water table and contaminate the public water supply is also presented. A set of questions asking for detailed information about subjects' current water usage. including their average monthly water bill, follows.

Next information IS presented about four alternate response options to a particular groundwater contamination scenario. Subjects are asked to think about and place values on each option. This seines as a framework within which to place further detailed context and information. Subjects are asked to read about and think about a hypothetical situation in which their groundwater supply has been contaminated by leachate from a municipal landfill. The risk level associated with drinking the water is stated as "about 10 additional deaths per million among people who drink the water per year" and a risk ladder comparing this risk to other risks is displayed. Subjects are told that, due to the groundwater contamination, there is a 50-50 chance of a 50% shortfall in the community's future water supply. The uncertainty resulting from variations in surface water availability was introduced to attempt to measure use value. They are then asked whether or not they would consider voting for a proposed referendum which would increase water bills to deal with the groundwater problem in a specified manner. If they state they would vote "NO." they are asked to write down an explanation. If they state they would vote "YES" they are asked What is the most your household would be willing to pay EACH MONTH on top of your current water bill before you would vote NO on OPTION X?" and are asked to circle a dollar value from a listing of 23 value choices ranging from $.50 to $500.

Each of these scenarios presents the identical groundwater contamination scenario, and they differ only in the response option being evaluated. The particular response options were chosen because they imply different combinations of use and non-use values and provide information on substitutes for complete cleanup. The specific options and their hypothesized value components are as follows:

OPTION 1: BUYING WATER FROM ANOTHER CITY: In this option the city proposes to deal with its groundwater problem in a temporary fashion by buying surplus water from another city for one year to make up the shortfall caused by the groundwater contamination. Responses to this option should include only use value since there Is no benefit to future generations and nothing is done about the contamination.

OPTION 2: IN-HOME WATER PURIFICATION This option presents the possibility of dealing with the groundwater problem privately versus publicly by having each homeowner install their own water purification system. Again, responses to this option should include only use value.

OPTION 3: CREATING A FUND FOR FUTUREUSE: In this option it is proposed to setup a fund which would earn interest and could be used in the future to deal with groundwater contamination in whatever manner people at some future point see fit. Responses to this option should include only bequest value and possibly some future existence value since there is no immediate use benefit.

OPTION 4: WATER SUPPLY TREATMENT: In this option the city proposes to deal with the groundwater contamination problem by building and maintaining a water supply treatment facility to clean up the water only as it is needed. It is not clear a ***priori*** precisely which value components people see as important for this response option: it should be mostly use and altruistic value, since the benefit is for immediate use and only what is needed is cleaned up, but some people likely view this option as providing, at least to some extent, continuous benefits to future generations since a treatment plant is constructed now.

Section 3 asks subjects to think about and evaluate one final response option which is described as a ‘complete groundwater treatment program.” In this option the city proposes to remove all of the contamination immediately by pumping up and cleaning the groundwater and removing the contaminated soil and placing it in a new, safe landfill. Responses to the COMPLETE GROUNDWATER TREATMENT option should include use, alturistic, bequest and existence values since all of the contamination is removed as soon as possible, providing both immediate and long-term benefits, and all of the groundwater is cleaned up immediately. It was expected that this option would prove to be the most popular (it was) and would seine as our best and most complete measure of overall value for groundwater protection. Subjects were then asked several follow-up questions in the survey immediately after their evaluation of this option. First, subjects were asked to estimate what percentage of their value was Included because of concern for "you and your family." "future generations,” and “not allowing contaminants to remain in the groundwater independent of any present or future use.”- ‘Ibis question gives us a method for separating out the use and non-use value components from subjects’ overall values. At this point in the research we were unaware of Madariaga and McConnell (1987) research on altruistic values so did not include this category. The final survey design described in Chapter V adds this category.

Second. subjects were asked to reevaluate the COMPLETE GROUNDWATER TREATMENT option for a one-time instead of a monthly water bill increase, so that any effect of "temporal embedding" (as described by Kahneman and Knetsch, 1992) could be examined. Third, in order to investigate and adjust for embedding, subjects were asked to reconsider their evaluation and state “about what percentage of their dollar amount was just for the stated groundwater program” rather than “a general contribution to all environmental causes.” Finally, subjects were also asked to rank order all six response option possibilities contained in the survey from most to least preferred.

Section 4 is a "debriefing" section designed to collect information on the strategies used by subjects to arrive at their contingent values and on the effects of specific categories of context and information on their judgments. Subjects first were asked to take a few minutes to write an open-ended description describing the “reasoning and strategies” behind their evaluation of the COMPLETE GROUNDWATER TREATMENT option. Subjects were then presented with eleven specific questions in which they were asked to go back to previous sections of the survey and assess what, if any, effect specific categories of context and information they had read about had on their evaluations.

Section 5 asks for the standard demographic information, including gender, age, education, ethnic background, and income.

The survey shown in Appendix A differs from that shown In Appendix B in that Section 3. the evaluation of the COMPLETE GROUNDWATER TREATMENT option, is presented twice: once just after the short . introductory section and before the long context sectin, and again after the detailed context has been presented. Instructions in this version make it clear to subjects that they will be making the same judgment of the identical scenario twice and that they should (a) treat the first judgment as a preliminary evaluation. while knowing they maybe presented information in later sections that might influence their judgment, and (b) treat the second judgment as their final evaluation, which they could choose to be the same or different from their preliminary evaluation, as they see fit.

Of course. the most critical sections of the survey for the research questions we wish to answer are those which present the detailed information and context about groundwater hazards and their remediation. In these sections we have made an effort to present as clearly and in as much detail as practicable (a) all of the information our subjects might want to have available in order to make an informed valuation based on USEPA's technical guidance and (b) all of the context which we are aware has been hypothesized to significantly impact contingent values. The following list describes five general categories of information/context included in the survey as well as their subcategories and potential effects:

1. Personal and community experience with groundwater. There are severat questions at the beginning of the survey which ask subjects in detail about the groundwater and landfill situation in their community and any local groundwater problems they have heard about. These questions likely induce people to think about their community's groundwater experience (and any potential implications for the valuation tasks in the survey) in much more detail than they otherwise would. The effect of these questions would likely depend on the individual's experience and what part of that experience -is most likely to be recalled. Since contamination incidents and problems are especially newsworthy and memorable, people may be more

likely to recall information that acts to increase their level of concern and increase their contingent value for that reason.

2. Groundwater information. There are several expository paragraphs in the survey which present information and facts about groundwater such as where it comes from, how it is extracted for human use, and how fast It moves. There is also a diagram which helps to explain how a community's groundwater supply could become contaminated by a leaky landfill. For many subjects, this information will be new to them or may contradict some assumptions they had made about groundwater. For example, most people overestimate the speed at which groundwater moves underground (often by orders of magnitude), and some clearly hold a mental model of groundwater as moving like an underground river. When told that groundwater in fact moves very slowly, they may decide that the problem is not so serious as they had thought and lower their value for groundwater protection. Alternatively, some people may decide the situation is worse than they thought because now they know the contaminantts will remain where they are and not be diluted, which may cause them to raise their value.

3. Economic information. At several places in the survey subjects are focused on certain types of monetary information. For example, at one point they are asked detailed questions about their water bill: later in the survey. they are presented cost information for an in-home water purification system. This monetary Information may serve as a cue or anchor for subjects when deciding how much they are willing to pay. Someone who was thinking of a very low value might, for instance, adjust their value upward after considering that what they were thinking of was just a small portion of what they pay for water; or, someone thinking of a very high value might

adjust their value downward after learning that the problem could be taken care of by private means for much less than they were thinking of paying.

Subjects are also presented in the survey a short section which explains the concept of discounting and points out to them that money paid now to solve environmental problems in the future will become more valuable as it earns interest over time. Some subjects might lower their value after considering this information since they realize they don't have to pay as much as they thought immediately to have a lot of money accrued in the future: alternatively, some subjects might raise their value after considering this information simply because they like the idea and feel that the discounting information means that whatever they can contribute is that much more valuable.

4. Alternative response options. A-e section of the survey is devoted to presenting in detail and focusing subjects upon the relative benefits provided by several different potential ways a community could respond to a groundwater contamination problem other than by implementing the COMPLETE GROUNDWATER TREATMENT program. These other options constitute substitute private or public goods for complete groundwater treatment. These options include buying water from a nearby city, simply employing water conservation techniques to decrease the amount of water the community needs, private options such as installing in-home water purification systems, creating a fund for people in the future to use to solve groundwater problems, and building a water supply treatment facility. Although some subjects may have thought of some of these possibilities on their own. it is unlikely given the unfamiliarity of groundwater problems that most subjects would considerall of these alternatives and their implications without the information provided in the

survey. This information might have varied effects. For example, some people may have been thinking of a high value simply because they were unaware there were alternatives which might cost less, and accordingly lower their values. Alternatively. other subjects may find fault with the alternative options and reading about them may point out benefits provided by the complete program which they had not realized before. These people might subsequently raise their value to account for this increased perceived benefit.

5. Risk communiction. In the survey subjects are presented with a "risk ladder" which compares the level of risk posed by groundwater contamination in the scenario they are judging with the magnitudes of several other well-known risks. This risk comparison information should act to give subjects a better understanding of the magnitude of the risk associated with the scenario they are valuing, but this understanding mayor may not increase concern for the risk. Some subjects may, after seeing the comparisons, realize that the risk posed by contaminated groundwater is truly quite low and not worth worrying about. If, however, subjects are simply unwilling to accept any level of risk whatsoever from groundwater contamination, these risk comparisons could have very little effect upon subsequent values.

It should be noted that the information and context manipulation in this study is limited to the categories of information and context described above and does not involve the. details of the hypothetical evaluation scenario (e.g., the level of risk or who was responsible for the contamination) or the details of the contingent valuation question (e.g., the payment vehicle or the referendum format). These variables were identical for all of the contingent values collected for the COMPLETE GROUNDWATER TREATMENT option.

4.1.2 Experimental Design

The experimental design is based on the differences in the surveys shown in Appendixes A and B. The survey shown in Appendix A was administered to one pretest group in October of 1990. These subjects were asked to make two evaluations of the COMPLETE GROUNDWATER TREATMENT option, once before being presented the detailed context and information, and once after. The survey shown in Appendix B was administered to a new set of pretest subjects in December of 1990. These subjects made only a single evaluation of the COMPLETE GROUNDWATER TREATMENT option after being presented the detailed context information. This design was chosen to allow the following comparisons to be tested.

(1) Comparing the preliminary and final values for the October pretest group allows a within-subjects test of the effect of perfect information/ complete context. The question here is, did providing context and information about groundwater cleanup cause subjects to revise their preliminary values in a predictable direction?

(2) Comparing the values for the December pretest group with the preliminary values for the October pretest group allows a between-subjects test of the effect of detailed context. The question here is, do values elicited from one group of subjects before perfect information/full context reliably differ in any way from values elicited from a separate group after they have been presented With perfect information/full context.

It should be noted that all three values obtained by this design (the preliminary and final evaluations of the COMPLETE GROUNDWATER TREATMENT OPTION for the October group and the corresponding final-only evaluations for the December group) were obtained with the exact same scenario and contingent valuation questions: the only difference was in the timing of presentation. The results of statistical tests based upon this design should allow clear predictions as to the direction and magnitude of any information/context effects as well as the implications of any such effects for national benefit estimation.

4.2 Survey Implementation

4.2.1 Pretesting Using Verbal Protocol Methodology

Prior to administration of the pretest surveys in October and December of 1990, preliminary versions of both were administered to 5 subjects each. These subjects were run individually and they were asked to "think aloud" as they read through the survey and answered the survey questions. After the think-aloud session they were asked several sets of debriefing questtons as well. Their "think-aloud protocols" were recorded and transcribed to provide a record of what subjects were thinking as they filled out the survey. The method and procedure for eliciting verbal protocols was adapted from Ericsson and Simon (1984). Verbal protocol techniques have the advantage of allowing the collection of individual data without contamination from other subjects (as would occur, for example, when pretesting a survey using a focus group) while minimizing experimenter demand effects (as might occur in a question-and-answer session with an experimenter) and self-presentation and memory bias effects (as might occur when asking subjects to provide self-reports of what they were thinking after the fact).

Our main purpose in collecting the verbal protocols was to aid in redesigning the surveys before proceeding with larger-scale pretesting.

Indeed, the verbal reports identified several places in the survey which were unclear or were not being interpreted by subjects in the desired fashion, allowing us a chance to correct such problems before the October and December pretests. For example, several subjects stated in their verbal reports that they were rejecting the COMPLETE GROUNDWATER TREATMENT scenario because they were worried that the groundwater might be contaminated again when the program was over: in later versions of the survey we were able to change the description of the program to assure that recontamination would not occur, and thereby help reduce the incidence of scenario rejection. Another problem was conti.mien over the water shortage scenario in which the 50% risk of a 50% shortage was to be evaluated. Several individuals interpreted the expected shortage as 50% rather than twenty five percent. Since EPA was interested in use value estimates of value, we temporarily left a clarified version of this scenario in the survey instruments for the next stage of pretesting.

A second purpose for collecting the verbal protocols was to help gain some insight into the processes people use to interpret survey information and to arrive at contingent values. For example, it is clear from the verbal protocols of several subjects that their zero bids are not true zero values but instead represent scenario rejecting, Le., dissatisfaction with some particular aspect of the scenario being valued. Samples from the verbal protocols and debriefing responses obtained from these subjects, arranged by conceptual categories, are presented In Appendix C.

4.2.2 Self-Administered Survey Pretests

The survey shown in Appendix A was administered to a group of 41 subjects in October of 1990, while the survey shown In Appendix B was administered to a separate group of 39 subjects in December of 1990. The two groups were recruited in an identical manner and did not differ reliably on age, gender, or income. The surveys were administered in person by an experimenter, not by mail or phone, so that any questions or problems with the purposefully long and complicated pretest instruments could be identified and answered.

Subject recruitment for the pretest studies was done by a marketing research firm experienced in recruiting people for studies of public issues. All subjects participating in the pretest sessions were from the greater Denver metropolitan area. No demographic restrictions were placed on subject eligibility, although telephone recruiters were instructed to obtain a good mix on such factors as gender, age, and income. Both afternoon and evening sessions were provided to help ensure recruitment of a diverse sample. Care was taken to ensure that subjects or my household members were not currently employed by a marketing research firm or any environmental, governmental, or legislative group. In addition, any subjects who had ever participated in a public issues session on a related topic or had participated in a public issues session on any topic within the past three months was disqualified. At the time of remitment, subjects were simply told that they were being recruited to participate in “a very special type of study in which we are inviting selected individuals like yourself to participate in a group session that will focus on public issues for a research group at the University of Colorado.” Subjects therefore did not know that the issue at hand was "groundwater protection” until the time of survey administration. On average, ten phone calls were necessary to recruit one subject; 45 subjects were recruited for each administration to obtain the final samples of 41 and 39 subjects.

Subjects were run in groups of 10 to 15 per session, and there were three sessions each in October and December. Subjects worked individually on the survey, and there was no discussion of the survey until after everyone had finished. Each of the conceptual sections of the s-was explained by the experimenter and administered separately. Subjects were allowed to keep all of the survey sections with them until the session was over so that they could refer back to them, if desired, during the debriefing sections. A typical session lasted one-and-one-half hours. After each session, subjects were thanked for their participation and the purpose of the survey was explained. Subjects were them paid $25 in cash for their participation.

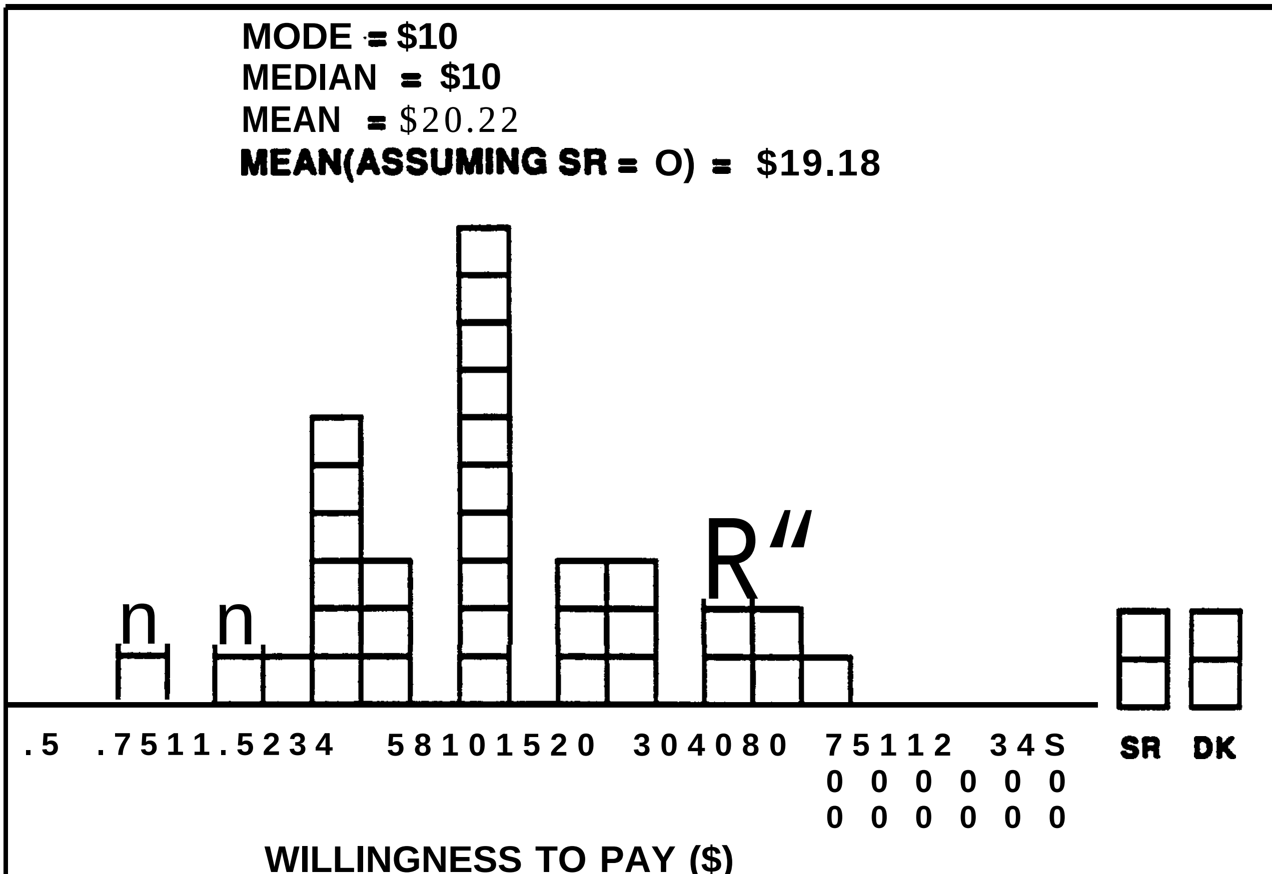
4.3 Survey Pre-Test Results

4.3.1 Frequency Distributions of Values

In designing the pretest surveys it was assumed that the COMPLETE GROUNDWATER TREATMENT option would be the most preferred and it was therefore presented to subjects as their main task in order to be utilized as their final, best value for protecting groundwater. This option was indeed the most preferred by the pretest subjects. Figures 4.1, 4.2, and 4.3 present frequency distributions of values for the October preliminary, December final and October final 1990 pretests respectively.

Figure 4.1 shows the preliminary monthly values for the COMPLETE GROUNDWATER TREATMENT option for the October 1990 pretest. These are values which were elicited at the beginning of the session before subjects were presented any information about groundwater or any detailed context; the complexity, detail, and wording of the scenario, however, was

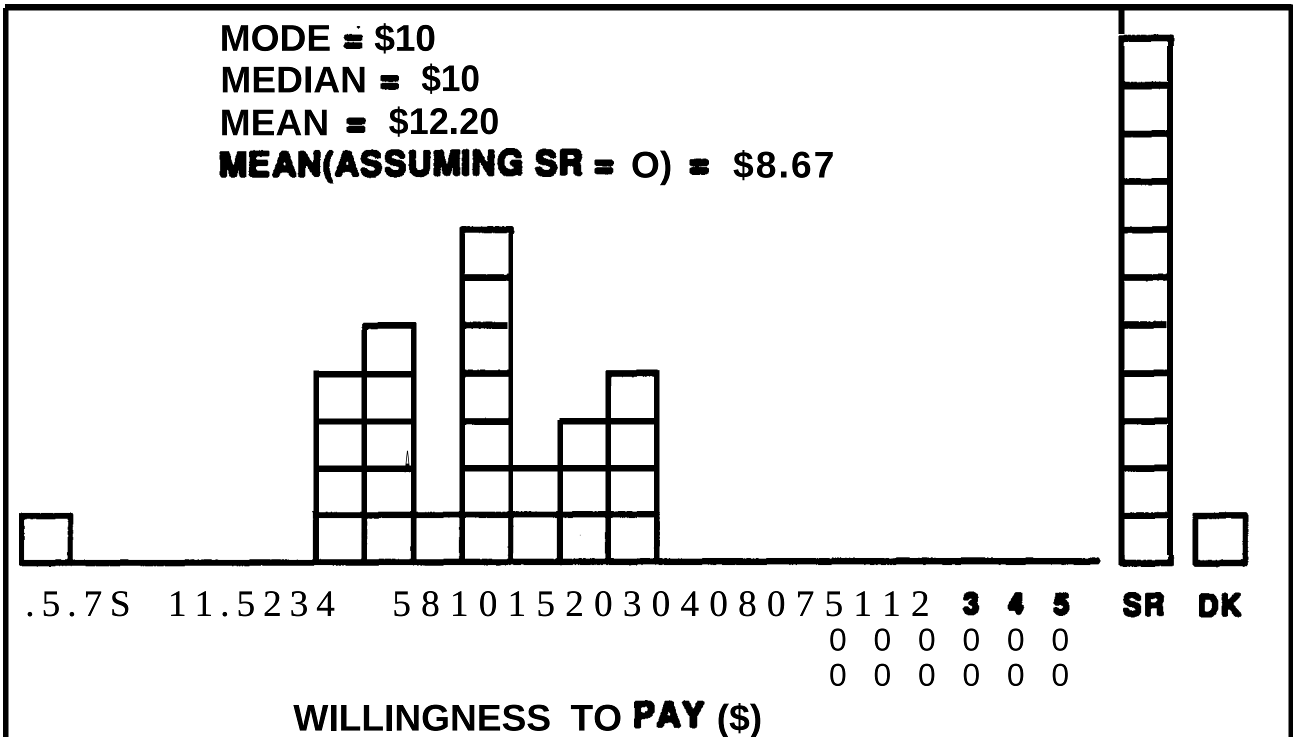
FIGURE 401: WTP FOR COMPLETE GROUNDWATER CLEANUP - OCTOBER 1990 - PRELIMINARY



distribution of preliminary monthly values (before context) for the COMPLETE GROUNDWATER TREATMENT option (October 1990 pretest). SR = scenario rejection: DK = don't know. These are the answers to Q-7 of Appendix A. In this and the following figures, each box represents one pretest subject. Also, the dollar bins along the horizontal scales here and elsewhere correspond to the options from which subjects chose their willingness to pay; note that the scales are not linear but are Instead quite compressed.

identical to that used in the final valuations. There is a lot of variance in the distribution the bids range from $1 up to $100 and the median ($10) and mean ($20.22) are highly discrepant. Even with this high variance, the mean Willingness to pay of $20.22 Is not unreasonable: it is likely that the

FIGURE 4.2: WTP FOR COMPLETE GROUNDWATER CLEANUP - DECEMBER 1990

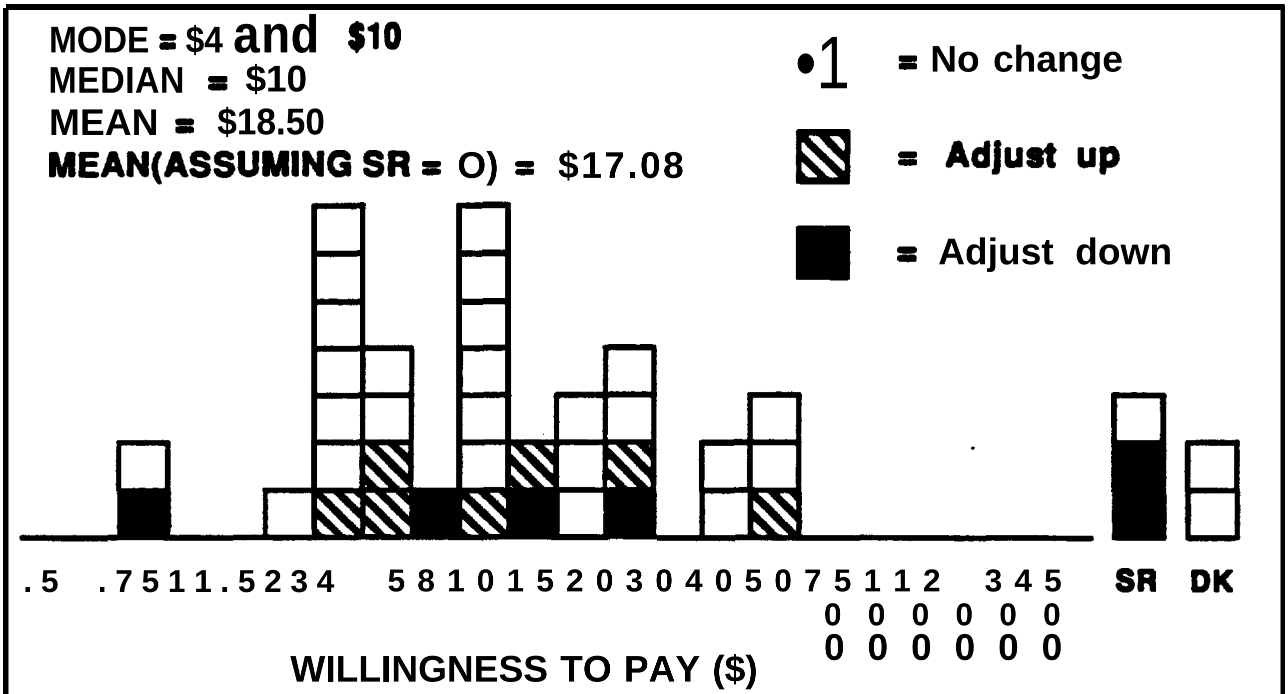


Distribution of monthly values (after context) for the COMPLETE GROUNDWATER TREATMENT option (December 1990 pretest). SR = **scenario rejection;** DK = don't know.

reasonableness and detail of the valuation scenario and willingness to pay question are doing some work in keeping values low over and above any effect of additional information and context. For example, the use of the water bill as a vehicle seemed to reduce embedding effects since it is more difficult to imagine money from a water bill increase to be used for other good causes such as education or cleaning up air pollution.

Figure 4.2 shows the monthly values for the COMPLETE GROUNDWATER TREATMENT option for the December 1990 pretest. These are values which were elicited only after subjects had worked through

FIGURE 4.3: WTP FOR COMPLETE GROUNWATERCLEANUP - OCTOBER 1990 PRETEST - FINAL (SHOWING ADJUSTMENTS FROM PRELIMINARY)



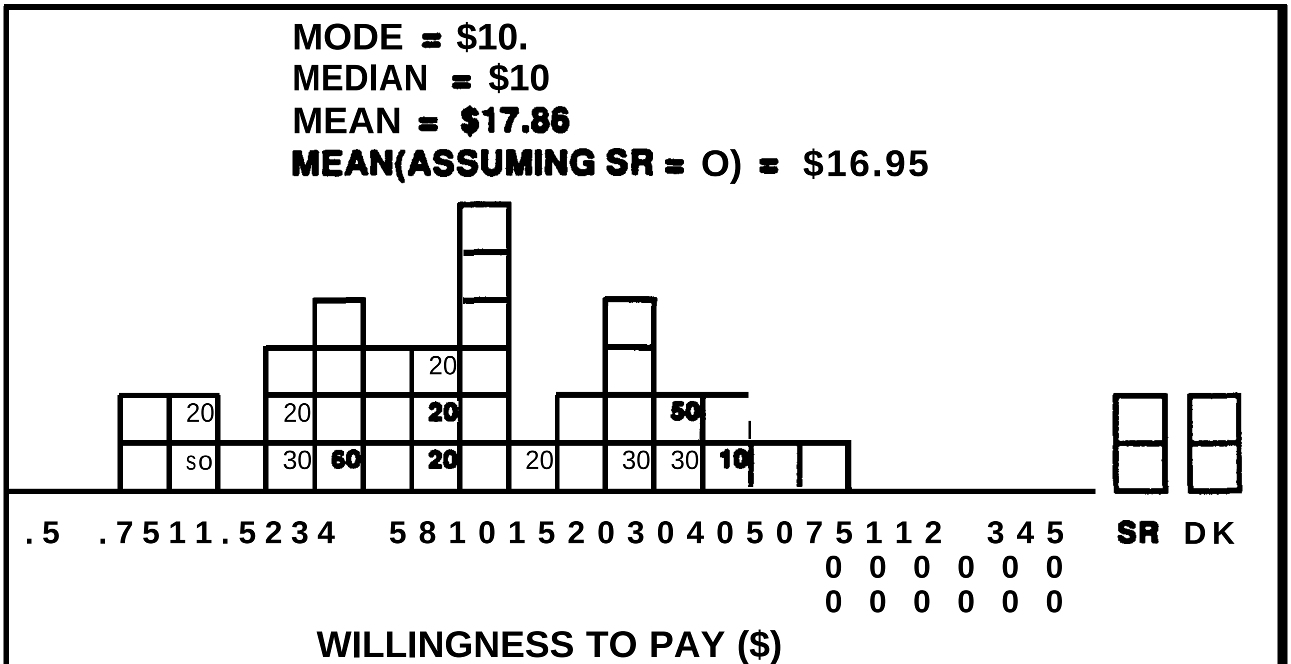
Distribution of final monthly values (after preliminary evaluation and after context) for the COMPLETE GROUNDWATER TREATMENT option (October 1990 pretest). SR = scenario rejection: DK = don't know.

all of the detailed context and alternate scenarios in the survey, and they had not made any preliminary evaluation of the scenario. There are two major difference between this figure and Fig. 4.1. First, the varl.ante Is much lower, and there are no extreme values. The mean willingness to pay is much lower ($12.20), although the median value is identical to that in Fig. 4.1. This suggests that detailed context may be working in some way to lower values that might otherwise be extreme, but that it has little affect upon values that are already relatively moderate or low. Second, there is much more scenario rejection than in the October 1990 pretest. Very few people. in fact, rejected all options. Most of the scenario rejection in the pretests was due to subjects preferring alternatives other than the final one, complete cleanup. This difference in scenario rejection raises another interesting point: although detailed context may have some beneficial effect in reducing the number of extreme values given by individuals, at the same time it apparently increases scenario rejection. In fact, the referendum format itself seemed to encourage scenario rejection when other substitute scenarios had been presented. For example, why would an individual who preferred water treatment vote for the complete cleanup option when the individual had already voted for the preferred option, water treatment. Since presentation of substitutes may account for much of the elimination of extreme values, we dedded to drop the referendum format in the next stage of the research.

Figure 4.3 shows the distribution of final monthly values for COMPLETE GROUNDWATER TREATMENT for the October 1990 pretest. These are values given by the same subjects shown in Fig. 4.1 after they had been presented the detailed context in the survey and been asked to reconsider their preliminary evaluation. Although the mean of the distribution ($18.50) is slightly lower than the mean of the preliminary values ($20.22), few people (13 of 41) in this within-subjects design were willing to revise their initial value. This suggests that if information and context is to have any effect, it must be presented before values are elicited.

Figures 4.4,4.5, and 4.6 show the same distributions as Figures 4.1, 4.2. and 4.3, respectively, after they have been revised to take into account subjects' self-reported reductions due to embedding. When asked whether or not their willingness-to-pay values were just for the stated groundwater program or to some extent a general contribution to other public goods or all environmental causes, roughly one-third of subjects, upon reflection,

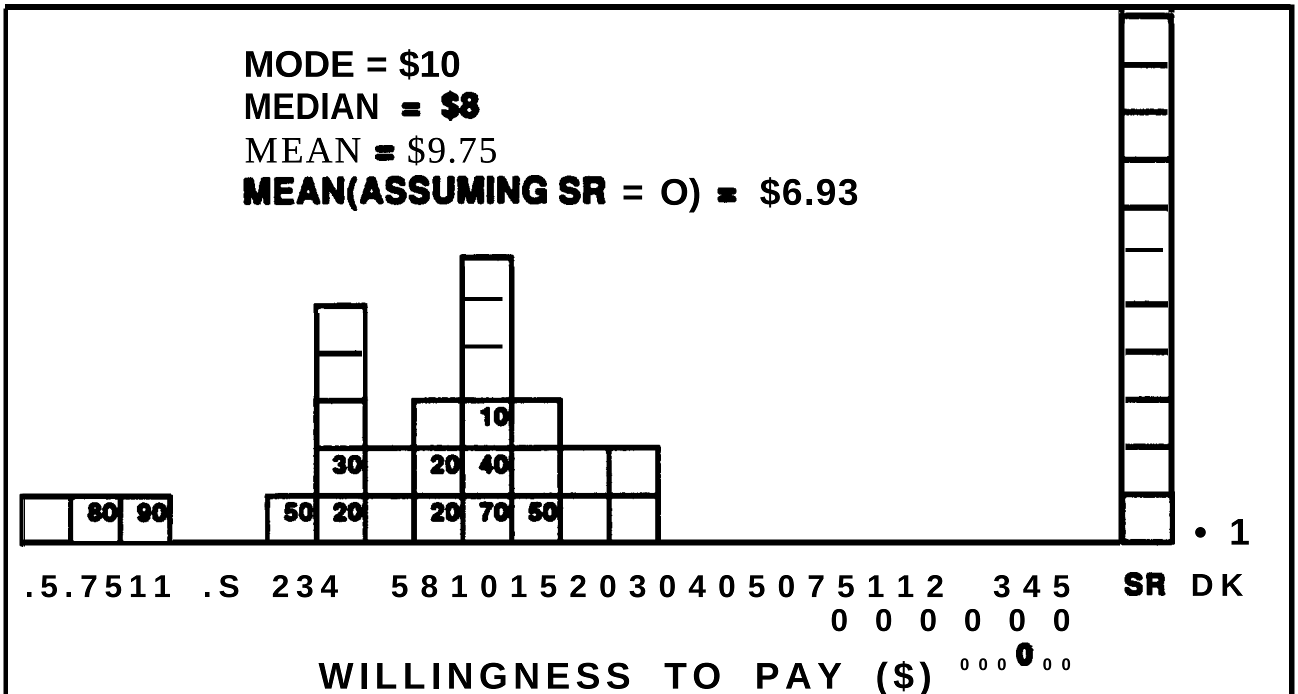
FIGURE 4.4: REDUCED WTP FOR COMPLETE CLEANUP - OCTOBER 1900 PRETEST - PRELIMINARY



Distribution of reduced preliminary monthly values (multiplied by the **percentage** reduction due to **embedding, Q-47,** Appendix **A)** for the **COMPLETE** GROUNDWATER **TREATMENT** option (October 1990 pretest). **SR** = scenario rejection: DK = don't know. Thirteen of the 41 subjects 'educed their value **in** response to **Q-47;** the exact percentage reduction for these **subjects is** shown in the boxes in the diagram.

stated a percentage reduction. Applying these percentage reductions to subjects' values reduces the means of the distributions, on average, by about 15 or 20% (for example, the mean of the distribution for the December 1990 pretest reduces from $12.20 (Fig. 4.2) to $9.75 (Fig. 4.5). However, the majority of subjects do not state a reduction, but instead claim that their entire value applies only to the specific program stated. These results suggest that embedding does occur to a substantial degree among at least part of the population and should be taken into account in survey design and in estimating use and non-use values. However, as noted in

FIGURE 4.5: REDUCED WTP FOR COMPLETE CLEANUP - DECEMBER 1990 PRETEST



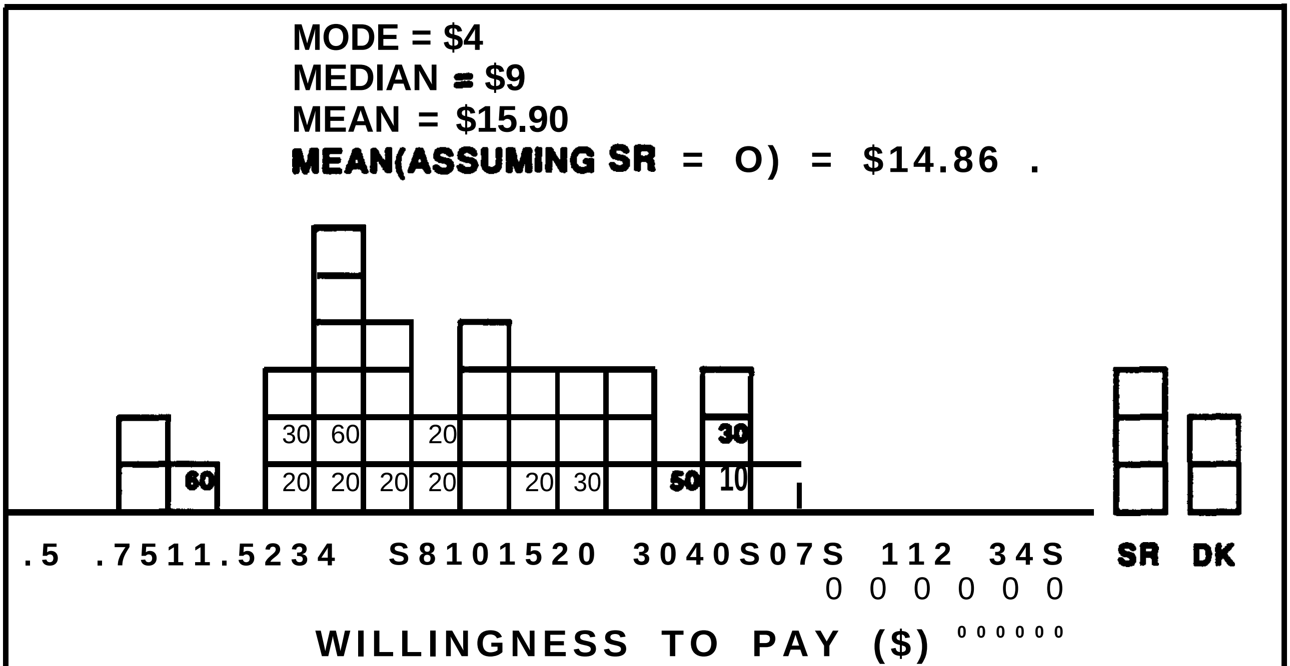
Idistribution of reduced monthly values (multiplied by the percentage 'eduction due to embedding, Q-45, Appendix B) for the COMPLETE GROUNDWATER TREATMENT option (December 1990 pretest). SR = scenario rejection: DK = don't know. Eleven of the 39 subjects reduced their value in response to Q-45: the exact percentage reduction for these subjects is shown in the boxes in the diagram.

Chapter III this percent level of embedding is the lowest we are aware of having been reported for any study employing debriefing questions of this type.

4.4 Estimates of Use Value

The pretest surveys were designed to yield several potential measures of use and non-use values. Each measure relies on one or more of the dollar responses to the groundwater protection options described in the survey.

FIGURE 4.6: REDUCED WTP FOR COMPLETE CLEANUP - OCTOBER 1990 PRETEST-FINAL

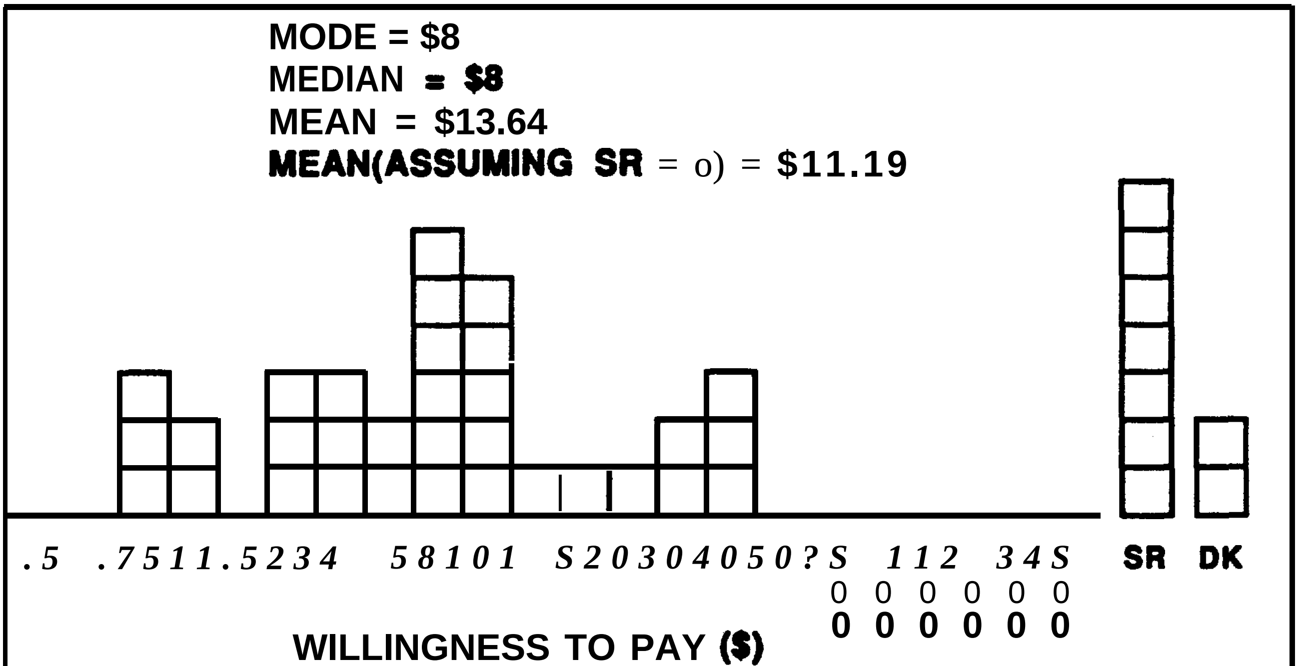


Distribution of reduced final monthly values (multiplied by the percentage reduction due to embedding, Q-47, Appendix B) for the **COMPLETE GROUNDWATER** TREATMENT option (October 1990 pretest). SR = scenario rejection: DK = don't know. Thirteen of the 41 subjects reduced their value in response to Q-47: the exact percentage reduction for these **subjects** is shown **in** the boxes in the **diagram.**

Each measure has its own advantages and disadvantages, which will be discussed below. It should be noted that the measures vary widely with respect to the degree to which they are affected by scenario rejection. all of the estimates employ values which have been reduced to account for self-reported embedding as described above.

It should also be noted that these pretest estimates maybe somewhat over- or underinflated due to order effects. For example, there was a trend in the data such that willingness to pay for groundwater protection tended to decrease over time. Since the BUY WATER option was always first or

FIGURE 4.7: VALUE FOR BUY WATER OPTION - USE VALUE METHOD 1-OCTOBER 1990 PRETEST

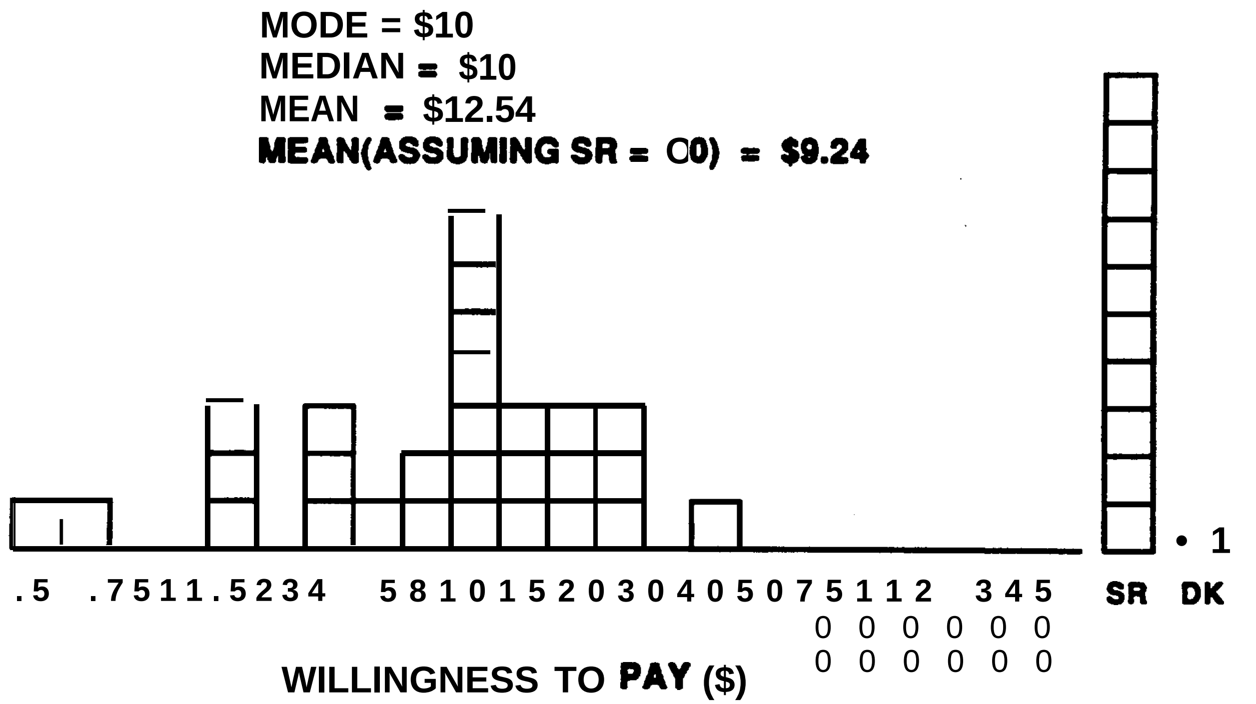


Jse value estimate, Method 1: reduced (from Q-47, Appendix A) monthly values for the BUY WATER FROM ANOTHER CITY option (October 1990 pretest). SR = scenario rejection: DK = don't know. Due to taking the percentage reductions due to embedding, some values here and in the following figures no longer correspond to the exact dollar bins shown. The reported means are based on the exact percentage-reduced responses.

second for the pretest subjects, use value estimates based on BUY WATER responses are likely to be overestimates. Or, it is possible that, since the CREATE A FUND FOR FUTURE USE option was the most highly rejected option and the WATER SUPPLY TREATMENT option was always next, WATER SUPPLY TREATMENT may have seemed especially valuable in comparison.

Figures 4.7 and 4.8 show the distribution of monthly values for the BUY WATER option for the October 1990 and December 1990 pretests, respectively (use value Method 1). These values should represent only use

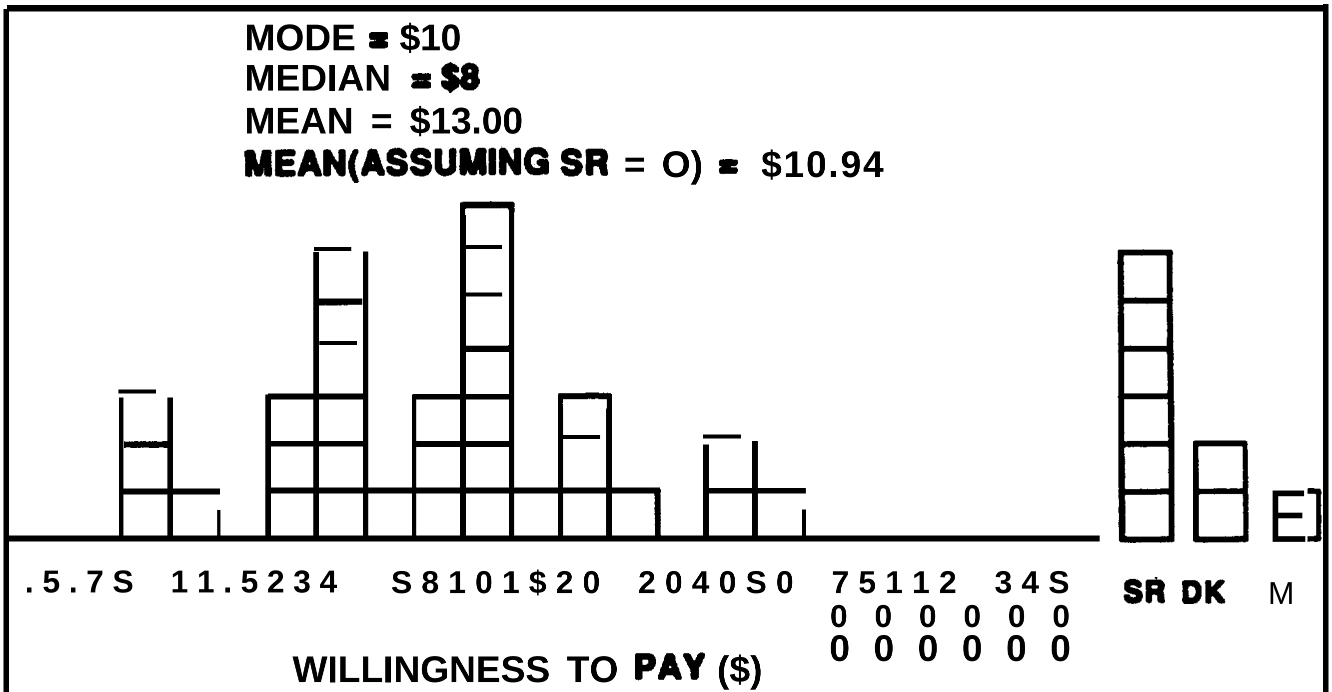
FIGURE 4.8: VALUE FOR BUY WATER OPTION - USE VALUE METHOD 1- DECEMBER 1990 PRETEST



Use **value** estimate, Method 1: reduced (from Q-45, Appendix B) monthly **values** for the BUY WATER FROM ANOTHER CITY option (December 1990 **pretest).** SR = scenario rejection: DK = don't know.

value since the program being valued is restricted to purchasing water to replace the contaminated groundwater that could no longer be used, it provides no benefit for future generations, snd it does nothing to improve the groundwater situation. The means of the distribution are very similar ($13.64 vs. $12.54) for the two pretest groups, although it should be noted that these estimates of use value are likely somewhat inflated because they are early estimates for both groups. The similarity of these distributions also provides evidence that the two pretest subject populations did not differ in their views at the beginning of the survey: the values for the COMPLETE GROUNDWATER TREATMENT option are lower for the December 1990

FIGURE 4.9 VALUE FOR WATER SUPPLY TREATMENT OPTION - USE VALUE METHOD 2 - -- 1990 PRETEST

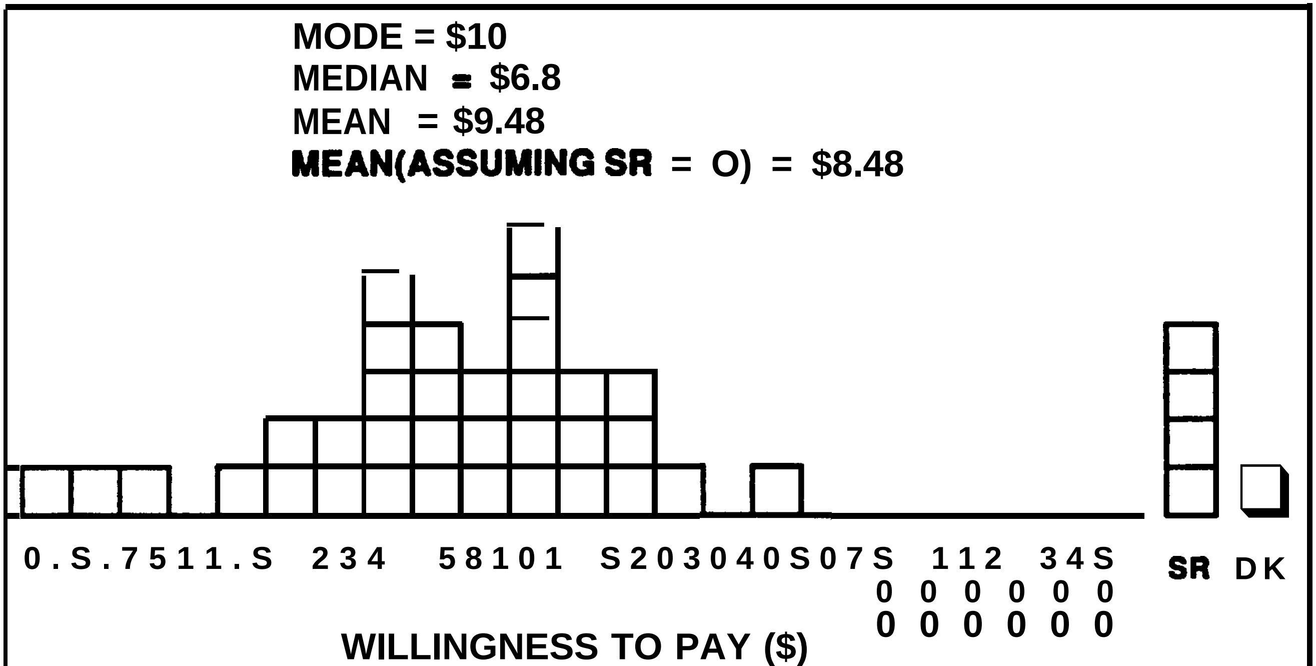


Use value estimate, Method 2: reduced (from Q-47, Appendix A) monthly values for the WATER SUPPLY TREATMENT option (October 1990 pretest). SR = scenario rejection; DK = don't know; M = missing data

group in spite of the fact that the values for BUY WATER are not substantially different between pretest groups. This suggests that any difference between the groups is not simply due to differences in the sample populations but is instead due to the information/context manipulation.

Figures 4.9 and 4.10 show the distribution of monthly values for the WATER SUPPLY TREATMENT option for the October 1990 and December 1990 pretests, respectively (use value Method 2). The mean of the distribution for the October 1990 group is $13.00, while that for the December' 1990 group is substantially lower ($9.48). This difference likely represents the differntial effect of context between pretest groups

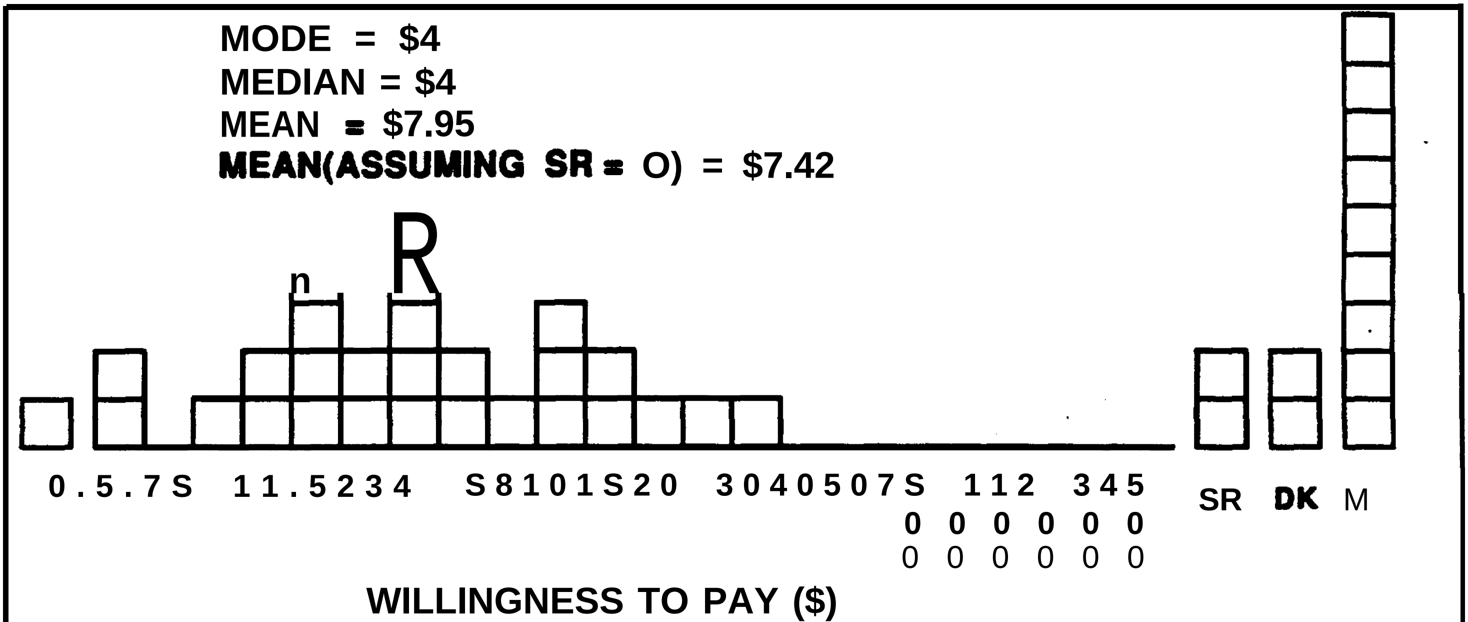
FIGURE 4.10 VALUE FOR WATER SUPPLY TREATMENT OPTION - USE VALUE METHOD 2 - DECEMBER 1990 PRETEST



Use value estimate, Method 2: reduced (from Q-45, Appendix B) monthly values for the WATER SUPPLY TREATMENT option (December 1990 pretest), SR = scenario rejection: DK = don't know.

described earlier in the values for COMPLETE GROUNDWATER TREATMENT. Unlike the BUY WATER option, however, it is unclear that subjects arc interpreting the WATER SUPPLY TREATMENT option as strictly a use value question some subjects instead see this option as preferable to COMPLETE GROUNDWATER TREATMENT because they prefer an option that takes care of the contamination as the water is needed, rather than cleaning up all the contamination at once and facing potential recontamination in the future. In this sense subjects may be interpreting the WATER SUPPLY TREATMENT option to have altruistic as well as some bequest and existence value components as well as a use value component.

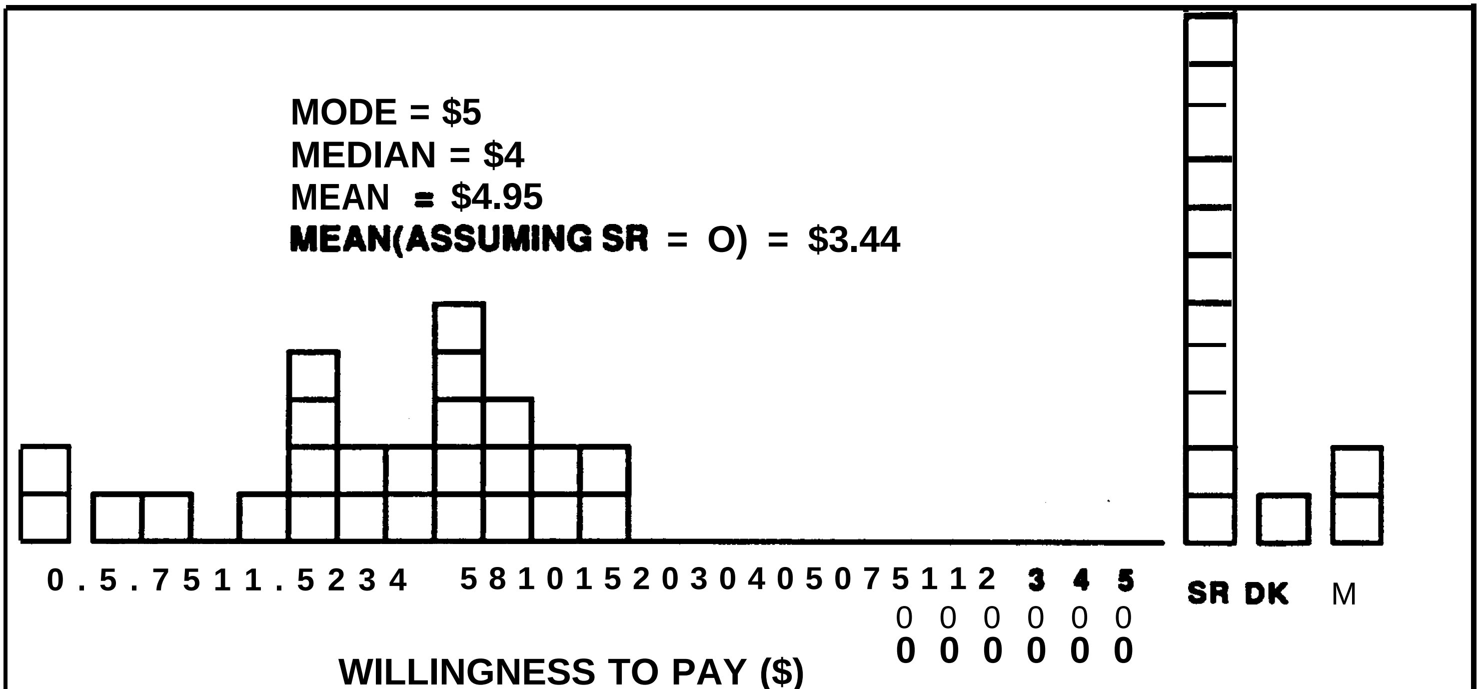
FIGURE 4.11: USE VALUE FOR COMPLETE GROUNDWATER TREATMENT - USE VALUE METHOD 3- OCTOBER 1990 PRETEST



Use value estimate, Method **3:** reduced **(from** Q-47, **Appendix A) final monthly** values for the COMPLETE GROUNDWATER **TREATMENT** option (October 1990 pretest), multiplied by the percentage stated as use **value** (from **Q-42, Appendix** A). SR = scenario **rejection;** DK = don't **know;** M = missing **percentage split.**

Figures 4.11 and 4.12 show the distribution of monthly values for the COMPLETE GROUNDWATER TREATMENT option multiplied by subjects* self-reported percentage attributable to use value for the October and December 1990 pretests, respectively (use value Method 3). This method attempts to extract the use value component of a value which naturally includes use value, bequest value (the water is cleaned up immediately for future generations), and existence value (all of the contaminants are removed from the groundwater as soon as possible) components. The mean of the distribution for the October 1990 group is $7.95, while that for the December 1990 group is substantially lower ($4.95). Both of these estimates are substantially lower than the estimates of use value derived by

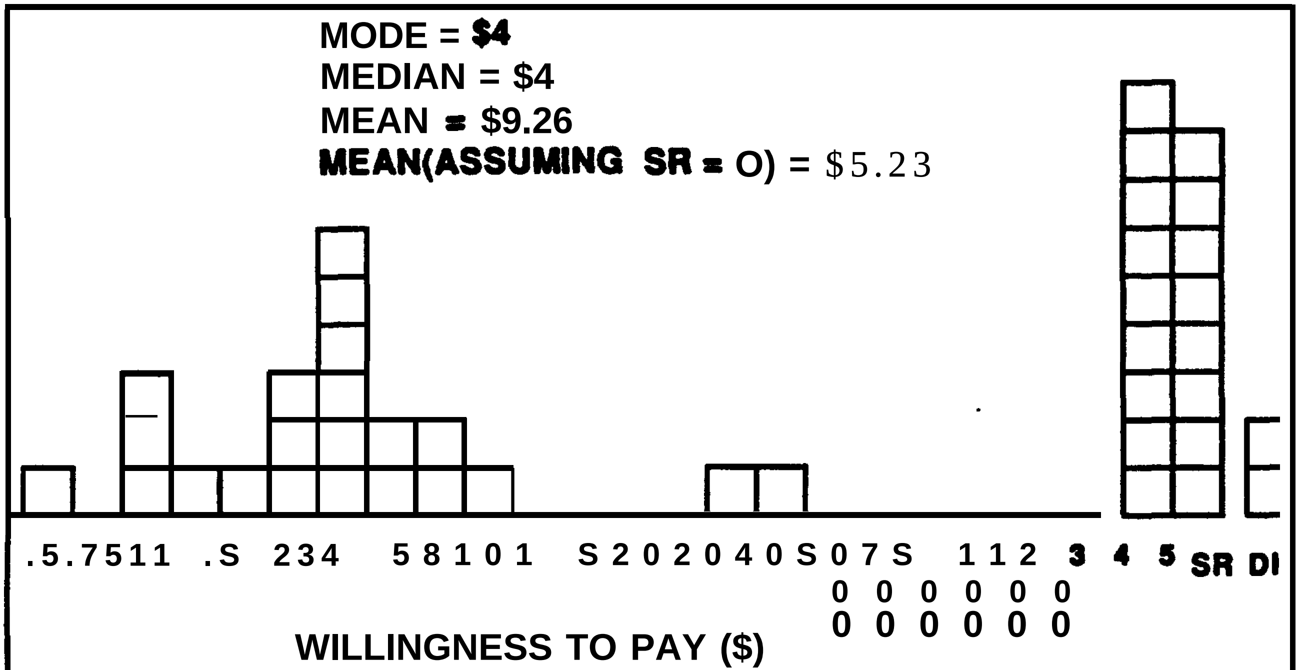
FIGURE 4.12: USE V“ FOR COMPLETE GROUNDWATER TREATMENT - USE VALUE METHOD 3- DECEMBER 1990 PRETEST



Jse value estimate. Method 3: reduced (from Q-45, Appendix B) monthly values for the COMPLETE GROUNDWATER TREATMENT option (December 1990 pretest), multiplied by the percentage stated as use value (from Q-40, Appendix B). SR = scenario rejection: DK = don’t know; M = missing percentage split.

Methods 1 and 2. Also, as was the case with Method 2, the December 1990 pretest group yields a significantly lower estimate than the October 1990 pretest group. One potential drawback with this method is that it is unclear how reliably subjects are at separating out after the fact components of values which were elicited globally. Also, some subjects are eliminated from the distribution by this procedure because they have difficulty assigning percentages to the different value components (Le.. the total percentage assigned did not add to 100%).

FIGURE 4.13: NON-USE VALUE FOR CREATE A FUND FOR FUTURE USE - NON-USE VALUE METHOD 1- OCTOBER 1990 PRETEST



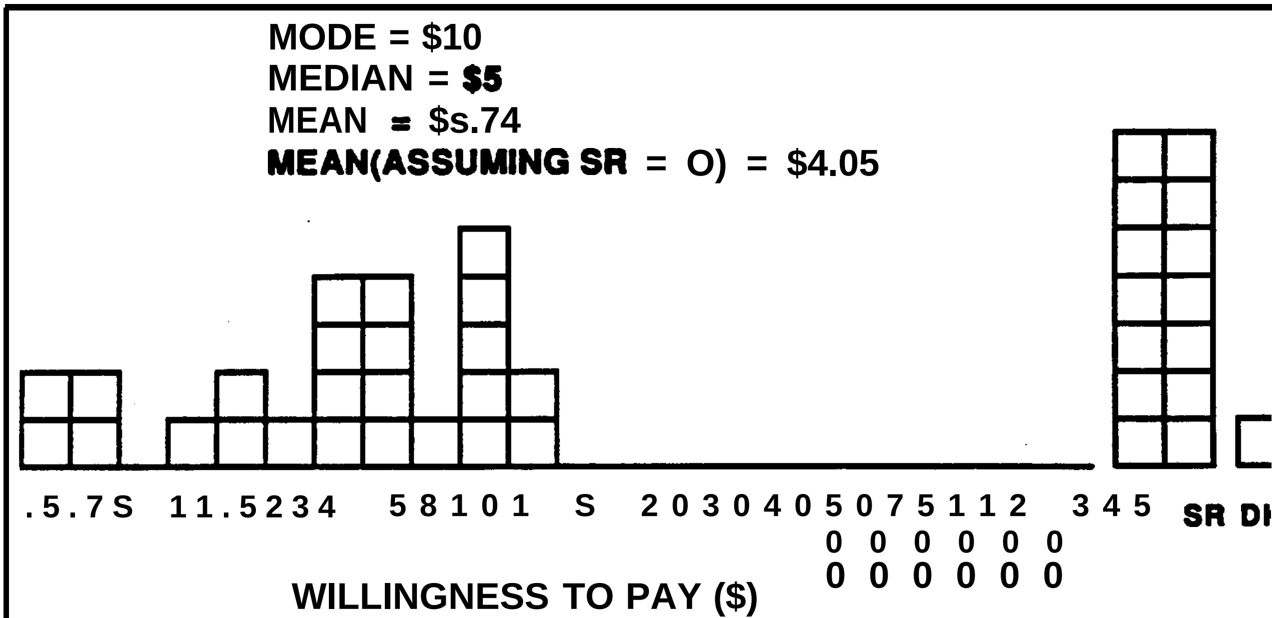
Non-use value estimate, Method 1: reduced from(Q-47, Appendix A) monthly values for the CREATE A FUND FOR FUTURE USE option (October 1990 pretest). SR = scenario rejection; DK = don't know.

4.5 Estimates of Non-Use Value

As we reported for use value in section 4.4, we report here three alternate methods for estimating non-use value for groundwater protection. For our purposes non-use value is defined as all value over and above use value and includes bequest value and existence value.

Figures 4.13 and 4.14 show the distribution of monthly values for the CREATE A FUND FOR FUTURE USE option for the October 1990 and December 1990 pretests, respectively (non-use value Method 1). These values should represent only bequest and future existence value since the

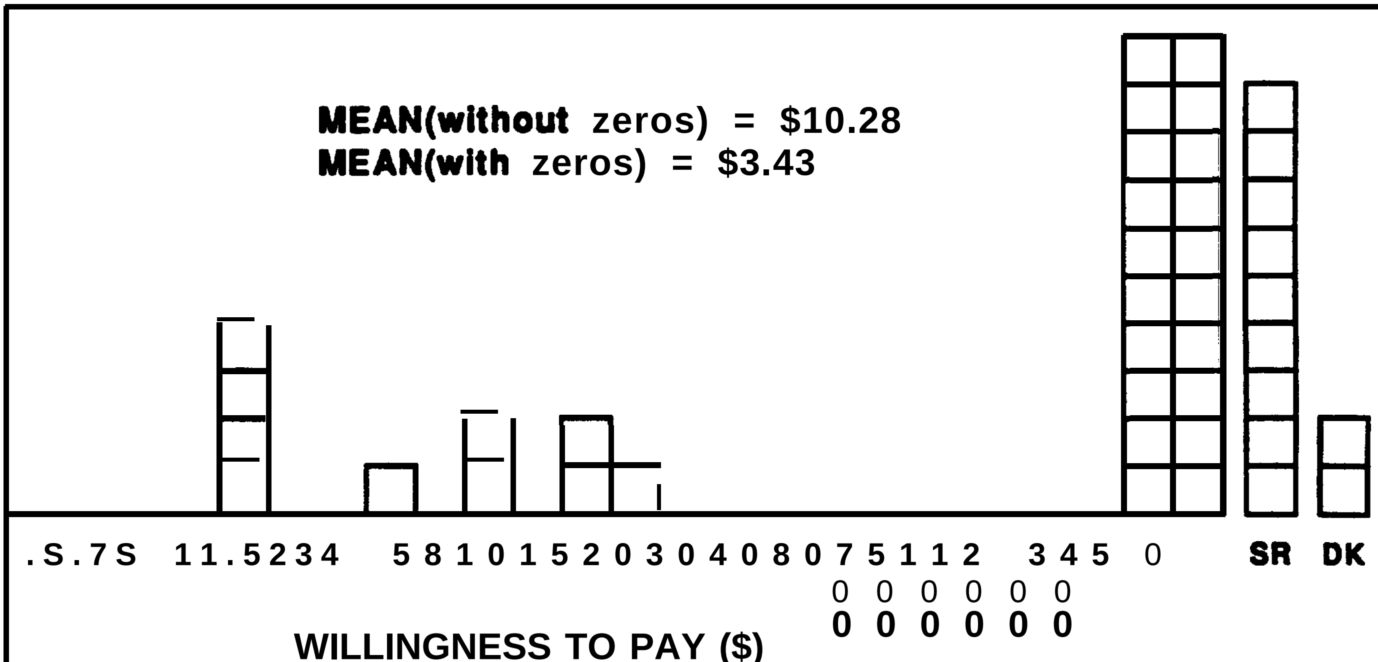
FIGURE 4.14: NON-USE VALUE FOR CREATE A FUND FOR FUTURE USE - NON-USE VALUE METHOD 1- DECEMBER 1990 PRETEST



Non-use value estimate, **Method** 1: reduced (from Q-45, Appendix B) **monthly** values for the CREATE A FUND FOR FUTURE USE option (December 1990 pretest). SR = scenario rejection: DK = don't know.

program is for future only and not present use. The most striking aspect of these distributions is the high degree of scenario rejection: over one-third of the pretest subjects rejected this option in both groups. Many people either do not believe that their money will truly be used for its stated purpose or believe that the program will be mismanaged. Others reject the program simply because they feel the groundwater problem should be dealt with more immediately by one of the other options. The mean of the distribution for the October 1990 group is $9.26, while that for the December 1990 group Is substantially lower ($5.74). This is further evidence, now in the domain of non-use values, that the average values of the

FIGURE 4.15 NON-USE VALUE METHOD 2 - COMPLETE GROUNDWATER TREATMENT MINUS WATER SUPPLY TREATMENT - OCTOBER 1990 PRETEST

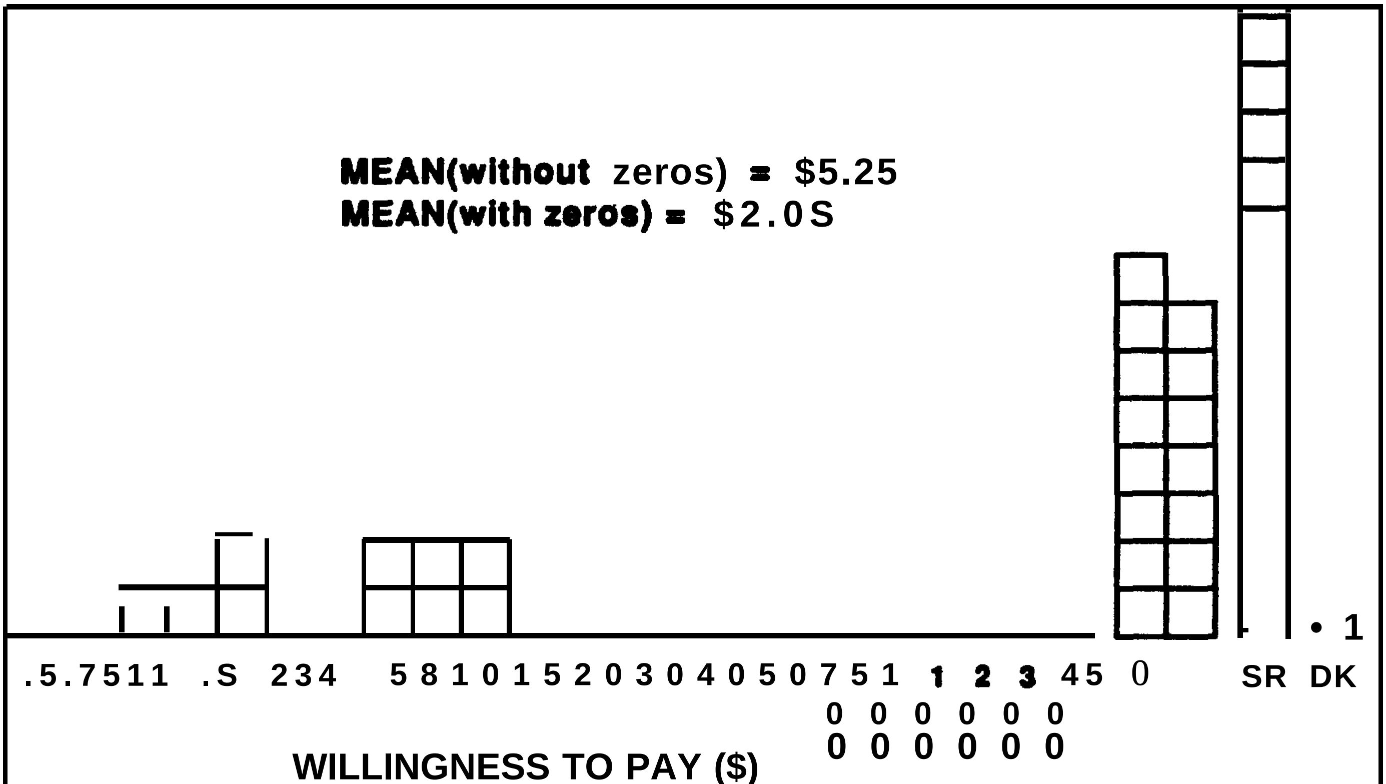


Non-use value estimate, Method 2: reduced (from Q-47, Appendix **A)** monthly **values** for the COMPLETE GROUNDWATER TREATMENT option - reduced **monthly** values for the WATER SUPPLY TREATMENT option (October 1990 **pretest).** SR = scenario rejection (one or both); DK = don't **know;** O = no difference.

December 1990 pretest group seem to rapidly become lower due to the relative absence of extreme values.

Figures 4.15 and 4.16 show the distribution of monthly values for the COMPLEtE GROUNDWATER TREATMENT option minus the monthly values for the WATER SUPPLY TREATMENT option for the October 1990 and December 1990 pretests (non-use value Method 2). This method Is based on the premise that the WATER SUPPLY TREATMENT option measures only use value, which, as discussed above, is problematic. Although the means of the two distributions ($10.28 and $5.25) are quite close to the respective

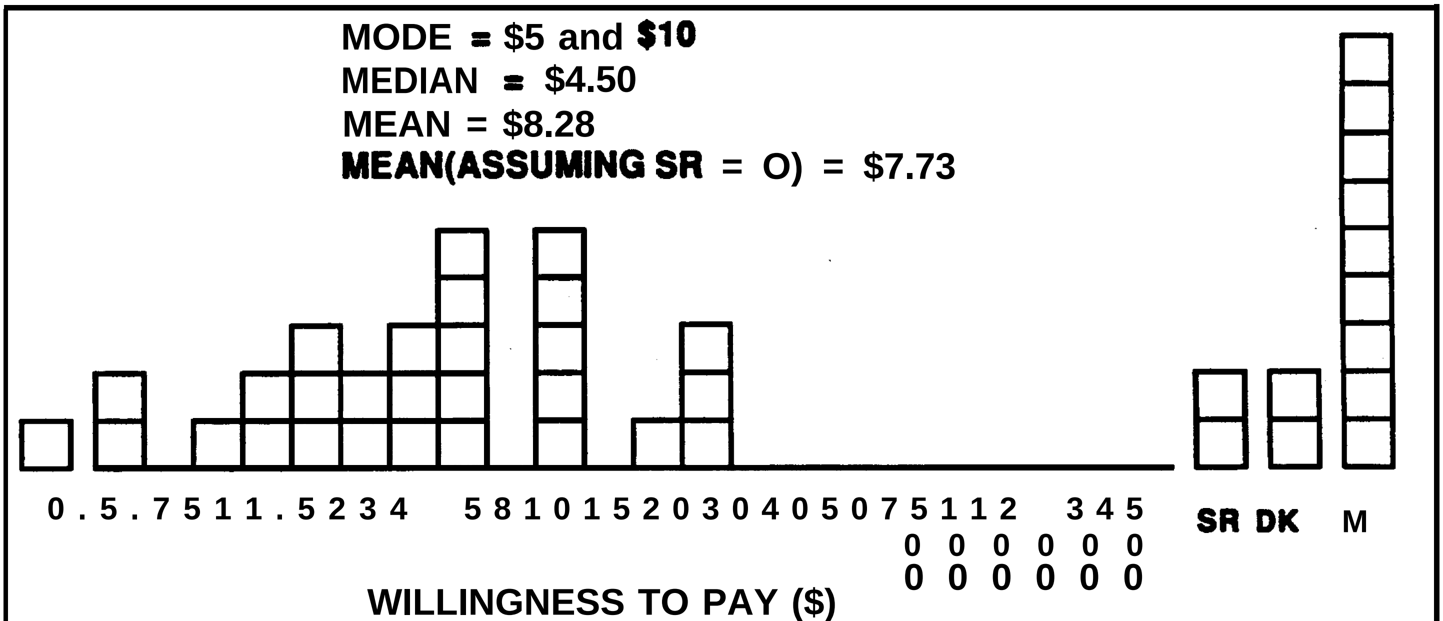
FIGURE 4.16: NON-USE VALUE METHOD 2- COMPLETE GROUNDWATER TREATMENT MINUS WATER SUPPLY TREATMENT - DECEMBER 1990 PRETEST



Non-use value estimate, Method 2: reduced (from Q-45, Appendix B) monthly values for the COMPLETE GROUNDWATER TREATMENT option - reduced monthly values for the WATER SUPPLY TREATMENT option (December 1990 pretest). SR = scenario rejection (one or both): DK = don't **know;** O = no **difference.**

means of the non-use value Method 1 distributions, these means are based on extremely few subjects due to the large number of subjects who rejected one or both of the relevant scenarios and to the large number of zero values (subjects who gave identical responses to the two scenarios). As noted above this method is likely to underestimate non-use values (especially if zeros are included) since some non-use values are included In the value for water

FIGURE 4.17: NON-USE VALUE METHOD 3 - COMPLETE GROUNDWATER TREATMENT TIMES PERCENTAGE FOR NON-USE - OCTOBER 1900 PRETEST

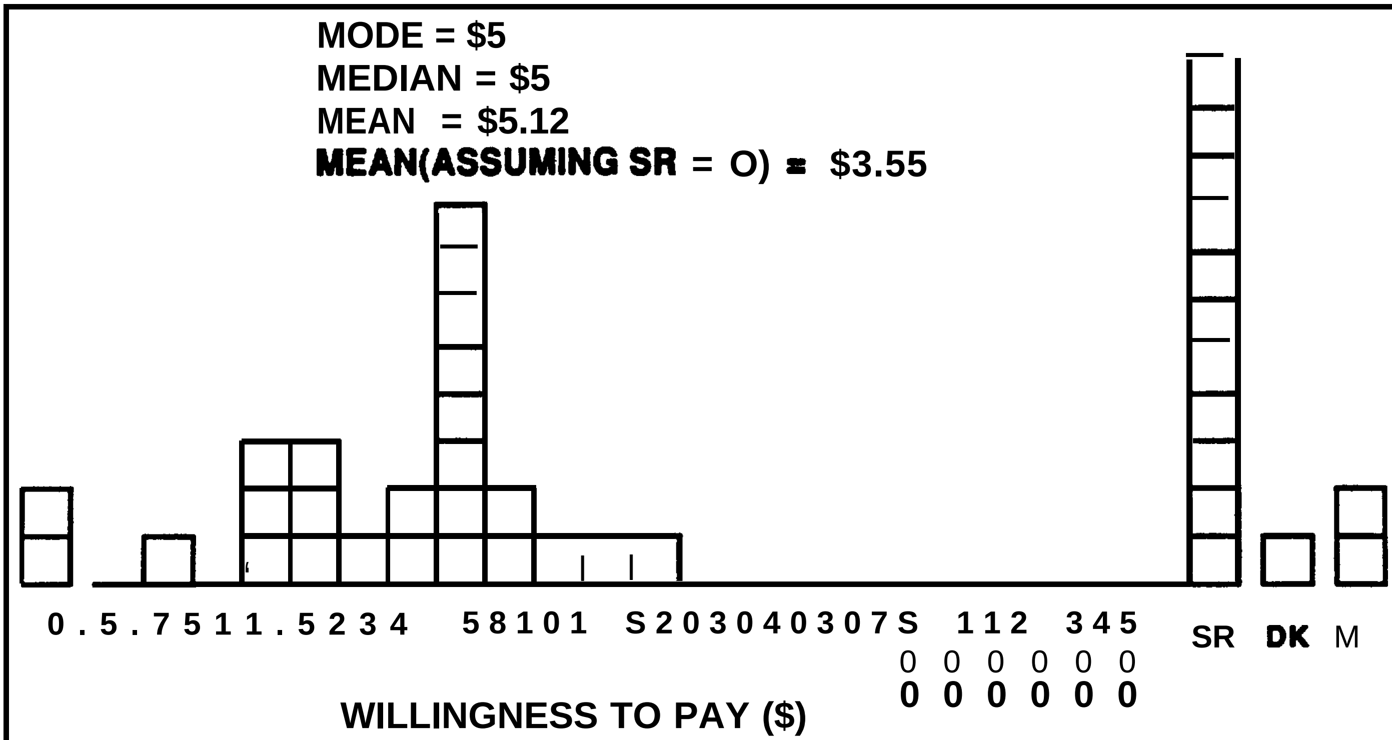


Non-use value estimate, Method 3: reduced (from Q-47, Appendix A) final monthly values for the COMPLETE GROUNDWATER TREATMENT option (October 1990 pretest), multiplied by the percentage stated as non-use value (from Q-42, Appendix A). SR = scenario rejection: DK = don't know; M = missing percentage split.

supply treatment and since some subjects may not recognize the difference in implications of the two scenarios.

Figures 4.17 and 4.18 show the distribution of monthlyvalues for the COMPLETE GROUNDWATER TREATMENT option multiplied by subjects" self-reported percentage attributable to non-use value for the October and December 1990 pretests, respectively (non-use value Method 3). This method is identical to use value Method 3, with the exception of multiplying by self-reported non-use value rather than self-reported use value, and it has the same strengths and limitations. The mean of the distribution for the October 1990 group Is $8.28, while that for the December 1990 group is

FIGURE 4.18: NON-USE VALUE METHOD 3 - COMPLETE GROUNDWATER TREATMENT TIMES PERCENTAGE FOR NON-USE - DECEMBER 1900 PRETEST



Non-use value estimate, **Method 3:** reduced from(Q-45, Appendix B) final monthly values for the COMPLETE GROUNDWATER TREATMENT option (December 1990 **pretest)**, multiplied by the percentage stated as non-use value (from **Q-40, Appendix A)**. SR = **scenario** rejection: DK = don't **know;** M = **missing** percentage **split.**

once again substantially lower ($5. 12). As was also true for use value, both of these estimates are lower than the estimates of non-use value derived by Methods 1 and 2.

Methods 1 and 3 for estimating non-use value make an interesting comparison. The values within a pretest group are quite similar, In spite of the fact that many subjects were removed from the Method 1 distribution due to scenario rejection. This is a strong indication that scenario rejection should not generally be interpreted as a zero value. Subjects who were not

willing to pay anything when evaluating non-use value in one way were willing to pay substantial amounts when evaluating non-use value in a different way.

4.6 Summary of Value Estimates

Table 4.1 summarizes the results of all three estimation methods for both use and non-use value and for both pretest groups. It is clear from this table that non-use value components such as bequest value and existence value are important for groundwater protection, perhaps as important as use values. By adding different use and non-use value estimates. it would be possible to obtain total monthly value estimates ranging from $10.07 to $23.92. The most obvious pattern evident in the table is that the estimates for the December 1990 pretest group are the lowest for all six methods.

A simple way to choose the best estimates for use and non-use value from this table would be to, first, assume that the results from the December 1990 pretest are more representative of people's true values since they were obtained after all information/context was presented and without implicitly encouraging subjects to "defend" a preliminary pre-context evaluation. Second, there are good reasons for choosing Method 3 for both intrinsic and use value: all of the other methods depend on values for options which may not be reliable. The BUY WATER option values are almost surely overestimates because they were always elicited before much of the detailed context. The WATER SUPPLY TREATMENT values are not unambiguously interpretable as representing strictly use values and the CREATE A FUND FOR FUTURE USE option was so often rejected that estimates based upon it cannot be regarded as representative.

TABLE 4.1: SUMMARY OF USE AND NON-USE VALUE ESTIMATES

Method	October 1990 Pretest	December 1990 Pretest
Use Value Estimates		
1) Monthly value for BUY WATER option	$13.64	$12.54
2) Monthly value for WATER SUPPLY TREATMENT option	$13.00	$9.48
3) Monthly value for COMPLETE GROUNDWATER TREATMENT X % use value	$7.95	$4.95
Non-Use Estimates		
1) Monthly value for CREATE A FUND FOR FUTURE USE option	$9.26	$5.74
2) Monthly value for COMPLETE GROUNDWATER TREATMENT - Monthly value for WATER SUPPLY TREATMENT	$10.28	$5.25
3) Monthly value for COMPLETE GROUNDWATER TREATMENT x % intrinsic value	$8.28	$5.12

By this logic, the lower estimate of $10.07 per month for total value for groundwater protection maybe preferable. It should be noted that this conclusion corresponds quite well to the medians and modes (but not the means) of all three distributions of values for COMPLETE GROUNDWATER TREATMENT presented in Figs. 4.1.4.2, and 4.3.

4.7 Debriefing Comments

After the main survey sections, subjects were asked an open-ended debriefing question and a series of more specific debriefing questions (Q-49 through Q-59 in Appendix A, Q-47 through Q-57 in Appendix B) about what parts of the surveyor items of information had any effect upon them when deciding on their values for the COMPLETE GROUNDWATER TREATMENT option. Since there was little revision of preliminary values for the October 1990 pretest group, we present here the debriefing results only for the December 1990 pretest group, who were not asked to make a preliminary evaluation and were therefore more likely to respond to context and information. Although these results are based on post-valuation self-reports. they provide several useful insights into what specific types of information and context may prove to have reliable effects on values as well as the direction of such effects.

Table 4.2 summarizes the self-reports of context effects from the December 1990 pretest, showing the percentage of subjects who indicated that information or questions in the survey had no affect upon their valuation of COMPLETE GROUNDWATER TREATMENT. caused them to lower their value, or caused them to raise their value for each of ten specific categories of information and context. The most striking element of this table is that the “no effect" category dominates for all ten types of information context in spite of the fact that information/context lowered the mean bid almost by half: even the categories which had the most self-reported effect on values were stated as having no effect at all by over 60% of the subjects. This suggests that information/context mostly effects subjects with extreme values. There are many reasons to expect context to make no difference in

TABLE 4.2 SELF-REPORTED EFFECTS OF CONTEXT - DECEMBER 1000 PRETEST

Self-reported Effects of Context from December 1990 Retest (Summary of responses to Q-47 through Q-56, Appendix B)

	Percentage				
Self-reported effect	Q-47 Pers. exp.	Q-48 Def. of gwater.	Q-49 Speed of gwater.	Q-SO Water bill	Q-51 Buy water option
No effect	75%	82%	90%	77%	67%
Lowered value	o%	3%	8%	8%	20%
Raised value	25%	15%	2%	15%	13%

	Percentage				
Self-reported effect	Q-52 Water cons.	Q-53 Private options	Q-54 Dis-counting	Q-55 W. S. T. option	Q-56 Risk commun.
No effect	72%	66%	79%	61%	76%
Lowered value	13%	24%	10.5%	34%	9%
Raised value	15%	11%	10.5%	5%	15%

the evaluations of many people especially in light of the fact that the modal value remains the same in both the perfectly informed/full context and limited information/limited context groups. First, some people's values may be already well-formed or "crystallized" and therefore resistant to new information. Second, some subjects are likely using very simplified heuristics to arrive at a willingness-to-pay value which are independent of or allow them to ignore much of the context information (e.g., spending as much as they feel they can afford, or spending their current water bull X 50%). Third, the context information may be something many people already knew about or thought about on their own. Fourth. some subjects may not attend to some context information because they do not believe it or they dislike its implications (e.g., people may overlook or ignore the price information given about private options in the survey because they feel the issue should be dealt with publicly). Finally, some of the context categories which experts and survey designers feel should be important in valuing groundwater protection maybe seen by lay people as unimportant or irrelevant.

The difficulty in predicting the effect of context and the difference between the perceptions of experts and lay people is well illustrated by three of the context categories in the table: information about the speed of groundwater, information about "discounting." or the manner in which money Increases in value over time, and Information about the objective level of risk and how it compares to other risks people face (the risk communication information given in the form of a 'risk ladder" in the survey). Experts on groundwater, economics, and risk would certainly take this information into account in their judgments and there would likely be general agreement among such experts as to the direction of the effect such information should have: the slower the speed of the groundwater, the less dangerous and costly the problem: one should discount one's present payments to take into account the fact that they will earn interest in the future; or, the lower the level of risk in comparison to other risks, the less one should be willing to pay to avoid the risk. Although only 10% of subjects reported that finding out about the speed of groundwater changed their value, 8% of these lowered their potentially extreme values. Twenty-one percent reported information on discounting to have an effect. However, precisely half raised their values and half lowered them. Twenty-three percent reported risk information to have an effect but in spite of the fact that the rtsk level stated in the scenario was chosen deliberately to be extremely low, about three fourths of these raised their value.

Certain categories of information and context do appear to have very reliable directional effects. Asking people to think about the groundwater situation in their own community, for example, caused 25% of subjects to raise their values and none to lower their values. Also, the information about other response options to groundwater contamination (for example, the possibility of buying water elsewhere, of using private options, or of treating the water only as it is needed) caused many people to lower their values, although a substantial, but smaller, number raised their values instead. The effect of these alternate response options may be generally to make people lower their values because they realize less expensive alternatives are available, although a few may raise their values after reading about these options because they make more salient certain benefits they were getting with the COMPLETE GROUNDWATER TREATMENT program which they had not previously thought of.

Another hypothesis concerning the implicit decline in groundwater values which occurs throughout the lengthy perfect information/full context treatment is that, just as is seen in laboratory experiments, repeated bidding encourages people to think about their values with a consequent reduction in bidding means and variances. Note that having people bid successively over different scenarios provides the “excuse” for obtaining repeated bids.

Finally, subjects were also asked whether going through the information and response options in the surveys “made them any more or less optimistic about our ability to deal with groundwater contamination problems now and in the future.” Fifty percent of subjects indicated that the information had indeed made them more optimistic, 37% indicated the information made no difference, and only 13% indicated the information made them feel less optimistic. These results suggest that there may, in addition to the effects of specific categories of information and context. also be some general context effect which is working to lower values simply because there is a lot of detailed information presented in the survey in a calm and reasonable manner.

4.8 Statistical Analysis of Pre-Test Results

Differences between the questionnaire as administered in October and December provide an experimental design that allows us to answer several important questions. This section reports the analysis of those questions.

In the October administration respondents initially gave their contingent values for complete groundwater treatment for a particular scenario. Then, after reading many pages of material designed to provide additional information and context and after providing contingent values for many other groundwater treatment options, they again gave contingent values for the same complete groundwater treatment option. Thus, the first question to be addressed here is. did providing the detailed contextual information about groundwater hazards and their remediation change contingent values in the aggregate? For the 36 respondents who gave both initial and final values the descriptive data[1] are:

Time	Mean	S.D.
Initial	17.22	19.70
Final	17.83	19.92

This very small difference between initial and final contingent values is not statistically significant ($t(35) = 0.62$, $p = 0.54$)[2]. Note also that there is negligible change in the variability of the individual responses. Thus, there is no indication that the additional information and context had any impact on values in the aggregate in this treatment.

We further tested the idea that providing initial values may have biased final values by removing the initial question from the December administration of the survey. Otherwise, those respondents in the December administration received the same context and information as the October group before providing their final value for complete groundwater treatment. It is therefore interesting to compare the values from the

[1]The data analyzed in this section arc the reduced values--the contingent values reduced by the proportion of that value the respondent said was clue solely to complete groundwater treatment rather than to other public goods and values. The results arc essentially the same whether the original or reduced values arc in the analysis.

[2]Note that in the paired ~-test each respondent serves as his or her own control. It is therefore neither necessary nor appropriate to control for personal characteristics such as income.

December group to each of the two values from the October administration. The comparison data for 27 respondents from the December group are:

Time	Mean	S.D.
Final.Dec	9.75	7.94

Both the mean and the standard deviation appear to be noticeably lower than for the October administration. In fact, the variances for the earlier groups are reliably different from the variance for the December group ($F(35,26)=6.16$, $p<.0001$ for the comparison to the initial October value and $X(35,26) = 6.29$, $p<.0001$ for the comparison to the final October value). The difference in the variances invalidates use of the common t-test for independent groups so we must use an adjusted t-test instead to compare the means. The means for either of the October values are statistically higher than the means for the December group ($t(48.7) = 2.06$, $p = .045$ for the comparison to the initial October value and $t(50.3) = 2.15$, $p = .037$ for the comparison to the final October value)[3]. It therefore appears that indeed giving the initial value biased the final value. Without the initial value, the context appears to have reduced both the mean and the variance for the December group.

However, a closer examination of the data reveals that the differences in both the mean and the variance appear to be due to individuals in the October group with extreme values. Further, the relationship between the mean and modal values in the above analyses is a clear indicator of skew as

[3]Note that the adjustment to the t-test for unequal variances involves adjusting the degrees of freedom, often to non-integer values as in this case. It is customary to control for income in analyses of contingent values. However, in this case income was not • significant predictor of values and its inclusion considerably complicates the analysis when heteroscedasticty exists, as it does in this case. Hence, income is omitted here. The corresponding analyses including income show the same result.

well as of heteroscendasticity. These are exactly the problems our analysis of errors in hypothetical values and empirical experience (see Chapter III) would lead us to expect. Both theory and expedence suggest that transformations would be appropriate both for removing the heteroscedasticity and the skewness induced by a few extreme values. It would be best to use the Box-Cox method for finding the best transformation as we did for the contingent values for improved air quality as described in Chapter 111. However, the present sample size is not adequate for the maximum likelihood estimation procedure. Instead, here we will use a log transform because it is both consistent with theory and close to the empirical transformations estimated in our other contingent value studies. The log transformed values from all the administrations are

Time	Mean	S.D.	Exp(Mean)
Initial, Oct.	2.20	1.21	9.02
Final, Oct.	2.26	1.16	9.58
Final, Dec.	1.89	1.03	6.62

Exp(Mean) is the geometric mean of the value. There is no longer any difference In the variances between the initial October and final December or between the final October and final December values ($F(35,26) = 1.40$, $p=.38$, and 1.27, $p=.53$, respectively). More Importantly, there is no longer any statistically significant difference between the means ($t(61) = 1.07$, $p=.29$, and 1.32, $p=.19$, respectively). Thus, once correcting for skewness and heteroscedasticty. there are no significant differences. This suggests, contrary to the earlier analysis of untransformed values. that information and context had little effect once the skewed distribution of hypothetical error was accounted for. Thus, a more parsimonious description of these results is that any differences between the two administrations can be attributed to the fact that information and context eliminated extreme values from the December group.

Using the untransformed values and assuming that the difference in raw values between those two administration represents a true effect of information and context the following argument can be made: the mean value from a survey with limited information and limited context would be about $17-$18 and the mean value from a survey providing perfect information and full context would be about $9-$10. However, simply taking the geometric mean of the limited Information/limited context survey would yield Exp(2.20) = 9.02. In other words, taking the geometric mean of the short limited information/limited context survey produces about the same estimate as the arithmetic mean of the values after perfect information and full context are provided. Thus, if the context effect in this analysis is real, then simply taking the geometric mean of the admittedly sloppy initial values has the same effect as providing full information and context. Taking the geometric mean of a short and inexpensive mail survey would obviously be more cost effective than administering a 20-30 page in-person interview required for perfect information and complete context. This interesting possibility needs verification in other studies of non-use values before it can be assumed to be a reliable approach. Furthermore, it should be noted that our limited information/limited context treatment still provides more information and context than many CV studies have employed in the past.

4.9 Conclusions

A number of the results of pretesting have major implications for the design of the national survey instrument.

- The 50-50 chance of a 50% water shortage caused by groundwater contamination remained a source of considerable confusion among subjects. many of whom interpreted this as an expected shortage of 50% rather than 25%. Thus, we concluded that a certain water shortage should be evaluated by respondents in the final surveydesign.

- The fund for future use scenario was overwhelmingly rejected by respondents and is unsuitable for use in the final survey design.

- The lengthy and complex risk ladder was used little by respondents and might well be deleted and replaced by one simple comparison to a well known risk.

- The inclusion of substitute options for complete cleanup seemed of considerable importance in subjects' construction of value for complete cleanup.

- However, the Inclusion of substitute options increased scenario rejection for complete cleanup since some subjects did not want to vote for a less preferred option. The no vote for complete cleanup did not correspond to a zero value, however. since these individuals in almost every case had voted for another option and provided a positive WI"P. Thus, the complete cleanup option implicitly did have some benefit for these individuals. In our previous work on the Brown Cloud air pollution study (see Chapter III), we found no difference between the referendum format and a dirtec WTP question so we conclude that a direct WTP question should replace the referendum approach for this particular commodity.

Self-reported embedding (about 20%) was as low as we have ever seen reported. Information and context appear to reduce self-reported embedding. In this case, the use of the monthly water bill seemed especially helpful.

- Depending on the results of further pretests, a shortened mail survey might be acceptable for two reasons: (1) Based on retrospective reports parts of the perfect information/complete context survey might well be shortened or deleted, and (2) The information and context provided appeared mostly to reduce extreme values, leaving the modal value unchanged. The Box-Cox transformation of values which we recommend in Chapter III eliminates or reduces the impact of extreme values, leaving the modal value unchanged. Thus, even if a shortened mail survey increases hypothetical error, it is plausible to suppose that a Box-Cox transformation may assist in allowing estimation of the underlying demand equation consistent with perfect information and complete context. This procedure, however. in our view, is no substitute for careful cognitive survey design.

In the next chapter we describe the design and testing of a mail survey based upon the perfect information/complete context instrument presented in this chapter.

Chapter V

Design and Testing of Mail Survey Instrument

5.1 Changes From Full information/Full Context Survey

In this chapter we discuss the changes made in survey design to develop a shortened instrument of mailable length. These changes were based on the results of verbal protocols, retrospective reports and debriefing information from the survey pre-testtng described in Chapter IV. In addition, changes were made based on additional technical information which became available following the initial design of the complete information/ full context survey. Finally, changes were adopted to reformat the survey into a mailable length and to develop additional variations of the base scenario to test for alternate aspects of valuation for both local and national groundwater cleanup.

The primary objective in redesigning the survey instrument was to maintain all information and context relevant for individuals to construct values for the scenarios described while trying to shorten the instrument to a mailable length. If an instrument containing all necessary information can not be made short enough for a mail survey. alternatives would include in-person interviews and administration in market research centers around the nation. The tradeoff between higher per respondent cost and the resulting representativeness of such a sample would be at issue relative to a mailable or in-person survey.

The instrument was shortened to twelve pages which is of mailable length. To insure that the shorter survey instrument had not deleted necessary information we re-tested the shortened instrument, again using a market research center. Statistical results from this re-test were compared to those from the initial pre-test described in Chapter IV. The comparison of values between the full information/full context surveys showed that the shortened survey instrument still seemed to provide adequate information for individuals to construct values corresponding to those in the longer instrument, especially as demonstrated by a comparable variance in the bids.

Several changes were implemented following the verbal protocols, retrospective reports and survey pretesting based on the conclusions presented in Chapter IV. These include the following alterations.

The 50-50 chance of a 50% water shortage was misinterpreted by many individuals. The 50-50 chance was replaced with a certain water shortage if no action for cleanup was to be taken. New text described the impending water shortage as a certain event resulting from groundwater contamination.

The scenario of a fund for future use was rejected by respondents in the verbal protocols and was dropped from the survey design as a method of estimating bequest values. As discussed in Chapter VII, alternative approaches to estimating non-use values proved quite successful in the final survey design although it may prove conceptually difficult for respondents to distinguish between bequest and existence values.

The risk ladder which had been used in the full information survey was removed, because individuals did not appear to make particular use of much of the information in the risk ladder. The statement regarding the comparability of the risks from x-ray exposure to the risks from groundwater contamination was retained in the early survey sections which develop information and context.

From the pretesting and verbal protocols it was obvious that the inclusion of substitute options was important to individuals for constructing their values. It was also found that using the referendum approach on each alternative led to scenario rejection of less favored alternatives. We therefore retained the information regarding alternative approaches for dealing with the groundwater contamination and the water shortage but did not have the individuals value each of these prior to valuing complete groundwater cleanup. Instead of using the referendum valuation approach on each alternative, the respondents were asked to indicate their level of satisfaction with each alternative on a scale of one to seven (1= not at all satisfied and 7 = extremely satisfied). Using this approach the respondents were able to consider substitute options prior to valuing complete groundwater cleanup. In addition, the valuation question for complete groundwater cleanup was changed from a referendum type question to a direct WTP question since previous work has suggested that there is little difference in the two approaches other than a reduction in scenario rejection.

To make the survey a mailable length the valuation questions for different scenarios were partitioned into different versions of the survey. These versions included two new scenarios described below. In four of the five versions of the survey (Versions A-D), individuals worked trough the exact same information and context sections before valuing the complete groundwater cleanup. Version E of the survey limited the information and context to test for the impact of the "quantity" of information and context on valuations. Following this valuation section the five different versions of the survey incorporated different sections to value different programs including public treatment, containment, national groundwater cleanup and different degrees of water shortfall.

Finally, the format for valuing alternative scenarios was changed. It was apparent from the analysis of the pretest results that the complete cleanup option was the most highly valued option for deling with groundwater cleanup. Based on this observatin, the valuation questions for the alternative scenarios were framed as a value relative to the value for the complete groundwater cleanup. Thus, using scales in which the value for the alternative scenario was stated as a percent of the value for complete groundwater cleanup would not cause the distribution of values to be truncated.

Two changes were made to the basic groundwater contamination scenario based on new technical information. First, the percentage of water shortage faced in the hypothetical scenario was changed from 50% to 40%. Second, the description of the physical size of groundwater contamination was lowered from two square miles to approximately five acres. This change was made based on information from the Office of Solid Waste of E.P.A. regarding the typical physical dimensions of actual groundwater contamination sites.

Other changes in the survey design were made to make the survey a mailable length and to attempt to estimate values for alternative scenarios not originally included in the full information/full context survey instrument. Following the research of Madariaga and McConnell (1987) a category for altruistic values was added to the question asking respondents for their component breakdown of their value for complete groundwater cleanup. This "altruistic" value asked what percent of their value did the respondent attribute to ensuring that "other households in your community have enough clean water to use."

The section of the full information/ full context survey described in Chapter IV as the debriefing section was removed. This section had been used primarily for analyzing respondents use of information and context for survey development. For purposes of re-testing the shortened survey design, a separate debriefing survey was administered which served the same purpose as this section but no longer needed to be included in the survey instrument.

The diagram illustrating the mechanism of groundwater contamination proved highly useful to respondents in understanding the information and context of the groundwater problem and therefore was placed on the cover of survey and referred to as needed in the survey text. Having the diagram on the survey cover helped to convey valuable information to respondents and increase interest in completing the survey. (This diagram is shown on the first page of Appendix D).

Three variants were added to the original survey design to gather information for policy purposes. First, information received from the Office of Solid Waste at EPA suggested that, in some situations, complete groundwater cleanup as proposed in the base scenario would not be technically feasible. As a "next-best" approach to solving groundwater contamination problems, a containment option was included among the alternative options to complete cleanup. Containment involves drilling wells around the contaminated area to prevent the flow of contaminated groundwater and the drilling of new wells in an uncontaminated protion of the aquifer to provide clean water for use.

A "National" variant question was added asking individuals how much they would be willing to pay to help clean up groundwater in other communities. Two versions of the nattonal groundwater question were developed, one a full context/full information question and the other a limited information/limited context question. In the full information variant used in one version of the survey, respondents were provided with information regarding the number of landfills nationwide and how many of these were expected to cause groundwater contamination. They were asked to help fund cleanup in communities other than their own that did not completely fund complete clean up locally. In the limited information variant individuals were not given information regarding the number of landfills nationwide or the likelihood of these contaminating groundwater. In addition they were not told that their payments would be supplemental to those already provided by the other communities. Note that for the local cleanup options presented, everyone would pay for cleanup through an increase in water bills.

Another version of the survey asked for willingness to pay depending on the degree of water shortage they faced. As described earlier the base scenario evaluated a situation where the individual's community faced a 40% water shortage due to groundwater contamination. This variant of the survey asked how much the respondent's WTP would change if faced with only a 10% water shortage or if faced with a 70% water shortage. Changing the magnitude of the current water shortage should change WTP for use and altruistic values but presumably not for bequest and existence values.

Including a Variant examining changes in WTP when faced with different levels of water shortage provides an additional method for estimating rim-use values. Two approaches were already available in the percent splits and scenario difference approaches already considered in the pre-test survey. The “percent splits” approach uses the component valuations individuals assign to their stated Willingness to pay treating bequest and existence values as non-use components. The “scenario difference" approach takes the difference between the WTP for complete groundwater cleanup and the public treatment option. The difference between these valuations will be bequest and existence values minus whatever bequest value the respondent places on the “bequest” of capital equipment to future generations in the form of a water treatment plant.

The variation of water supply shortage presents a third approach for estimating non-use values by extrapolating the valuation to a condition of zero water shortage. Using within-subject data on WTP when faced with 10%, 40% or 70% water shortages a quadratic equation can be fitted with WTP as a function of water shortage. Setting the water shortage due to contamination equal to zero, the vertical intercept of the quadratic equation, the predicted value will be entirely bequest and existence values since there will be no loss of use under zero percent water shortage. As the WTP values used in the extrapolation approach are the reduced WTP values, the vertical intercept derived using this approach are values just for clean groundwater and not for other environmental or public goods. Chapter VII describes and compares the results of these three approaches for measuring non-use values for the national groundwater survey.

5.2 Survey Design

The shortenedsurvey instruments (shown in final form in Appendix D) contained six sections, one of which was varied In each of the five versions of the survey to answer a variety of questions.

The survey cover provides an introduction to the survey by presenting the title of the survey in question form and showing the respondents the diagram of the scenario to be valued. The cover asks for the head of the household to complete the survey and return the instrument to the Center for Economic Analysis at the University of Colorado.

The "Issues" section presents the respondent with information regarding the extent of use of groundwater and has the individual consider his or her own use of groundwater and possible contamination. This section retains much of the context and information from the full information/full context survey to let the individual understand the problem of groundwater contamination, how such contamination affects him or her and how this problem compares to other public policy issues.

The "How Communities Can Respond to Contaminated Groundwater" presents the individual with the hypothetical scenario to be valued and presents several alternatives to complete groundwater cleanup. This section includes Information regarding the physical scenario to be valued. the risks involved and the need to do something about the problem. It is emphasized that standard landfill practices caused the problem so that individuals will not reject the payment scenario if they feel that those who cause the problem should pay for it. In addition to the complete cleanup option, containment public treatment, home treatment and water rationing are described and the individuals are asked to indicate their level of satisfaction with each of these options.

The next section, “How Much Is It Worth to You to Completely Clean Up Contaminated Groundwater?." asks the individual how much he or she is willing to pay to completely clean up groundwater if faced with the hypothetical situation outlined in the previous seciton. It is emphasized that costs are not known at this time and that the program would only take place if it costs less than people were willing to pay. It is emphasized that scientists are satisfied that the program can be completed as described and that recontamination would not occur. The willingness to pay question is followed by disembedding, component splits and responsibility questions.

Following the complete cleanup valuation section each version of the survey incorporated a different section designed to examine specific valuations. The five versions of the survey are characterized in Table 5.1.

The final section of all versions requested socio-demographic information from the individuals including income. age, ethnicity, gender, education, and household composition. Further questions related to environmental “awareness” in terms of how much the individual recycles materials and of how many environmental organizations the individual has joined.

5.3 Survey Implementation

The shortened survey instrument was pretested on October 12, 1991 in Denver at a marketing research firm. The firm recruited a total of 117 individuals to participate In a survey dealing with public policy issues. Individuals were randomly assigned to five different groups each of which

TABLE 5.1: DIFFERENT VERSIONS OF MAIL SURVEY

VERSION	TITLE	DESCRIPTION
A	HOW MUCH IS IT WORTH TO YOU TO PREVENT FURTHER SPREADING OF CONTAMINATED GROUNDWATER?	Value for groundwater containment program
B	ABOUT THE NATIONAL GROUNDWATER PROBLEM	How much individual is willing to help to pay for other communities to clean up their groundwater contamination problems - full context and information
C	HOW MUCH IS IT WORTH TO YOU TO HAVE A CLEAN SUPPLY OF WATER?	Willingness to pay for a public water treatment program
D	WHAT IF YOU FACED A DIFFERENT LEVEL OF GROUNDWATER CONTAMINATION	How the degree of water shortage affects the willingness to pay - if faced with a 10% or a 70% water shortfall instead of the 40% shortfall
E	ABOUT THE NATIONAL GROUNDWATER PROBLEM	Same as Version B except with limited context and information

completed one of the versions of the survey. Following completion of the survey the participants were given a separate debriefing questionnaire to complete. They kept the valuation survey to refer to while completing the debriefing questionnaire. The complete process took about an hour for which individuals received $25.00 cash.

Table 5.2 presents socio-demographic information regarding the Denver pm-test subjects.

TABLE 5.2: SOCIO-DEMOGRAPHIC INFORMATION - DENVER PRE-TEST - OCTOBER1991

TOTAL NUMBER OF SUBJECTS	117
GENDER	43 FEMALE 73 MALE 1 NO ANSWER
AVERAGE AGE	44 YEARS
AVERAGE EDUCATION LEVEL	SOME COLLEGE
AVERAGE INCOME	$41,853
INCOME DISTRIBUTION	UNDER $9,999 3 $10,000 to 19,999 12 $20,000 to 29,999 27 $30,000 to 39,999 23 $40,000 to 49,999 14 $50,000 to 59,999 17 $60,000 to 69,999 8 $70,000 to 79,999 2 $80,000 to 89,999 7 over $90,000 3 no answer 1
ETHNIC GROUP	CAUCASIAN 106 AFRICAN AMERICAN 5 HISPANIC 1 ASIAN 3 OTHER 1 NO ANSWER 1

5.4 Results

5.4.1 Frequency Distributions of Values

The obtained willingness to pay values for the various programs are presented in the Figures 5.1-5.8. The distributions are plotted on log-dollar scales which essentially normalize the distributions. The vertical scale indicates the percentage of responses falling into each “bucket.”

Reduced willingness to pay for complete groundwater cleanup (from Versions A, B, C and D) is presented in Figure 5.1. Figure 5.2 presents the distribution of WTP for complete cleanup for the no-context version. The geometric mean (anti-log of the mean of log WI’P) of reduced WTP for complete groundwater cleanup is $5.86 for the full context surveys and $7.30 for the no-context survey Version E. tHE reduced willingness to pay for complete groundwater cleanup is the willingness to pay for the program adjusted to account for self-reported embedding. This value was derived in all five versions of the survey, but Version E is a low-context variant so it is treated separately. The modal value in the no-context Version E is the same as in the full-context survey versions but the distribution has a higher variance with more of a right skew.

Figures 5.3 and 5.4 present the distribution of willingness to pay for the public treatment and containment options respectively. The geometric mean for these distributions are $1.62 for the public treatment program and $1.46 for the containment program. The apparent discontinuities in these distributions are attributable to the relatively small sample sizes of 22 respondents for each version. As for the distribution of WTP for complete cleanup, these distributions are close to log-normal distributions.

Figure 5.5 and 5.6 presents the distribution for willingness to pay for the national groundwater cleanup program for Version B (full context) and Version E (low context) respectively. The geometric mean for the full-context national WTP is $0.46 and for the low-context national WTP is $0.76. Both distributions are essentially log-normal truncated at zero. The no-context distribution has significantly higher variance than the full-context distribution as discussed in Section 5.5.

Figures 5.7 and 5.8 present the distributions of WTP for complete cleanup of contaminated groundwater under conditions of 10% water shortage and 70% water shortage respectively. The geometric means for WTP are $2.97 with a 10% water shortage and $10.38 with a 70% water shortage. As in the other distributions of WTP in the Denver pre-test, the small number of observations may cause apparent discontinuities in the graphs of the distributions which are very close to log-normal distributions.

FIGURE 5.1: REDUCED WILLINGNESS TO PAY FOR COOMPLETE CLEANUP
FULL CONTEXT VERSIONS
OCTOBER 1091- DENVER PRETEST

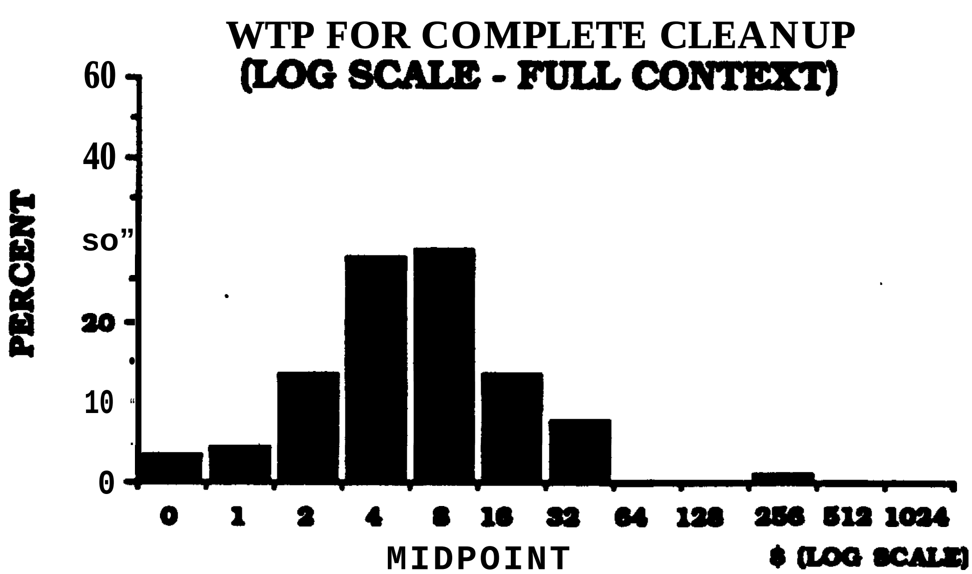


FIGURE 5.2: REDUCED WILLINGNESS TO PAY FOR COMPLETE CLEANUP - NO CONTEXT VERSION
OCTOBER 1991- DENVER PRETEST

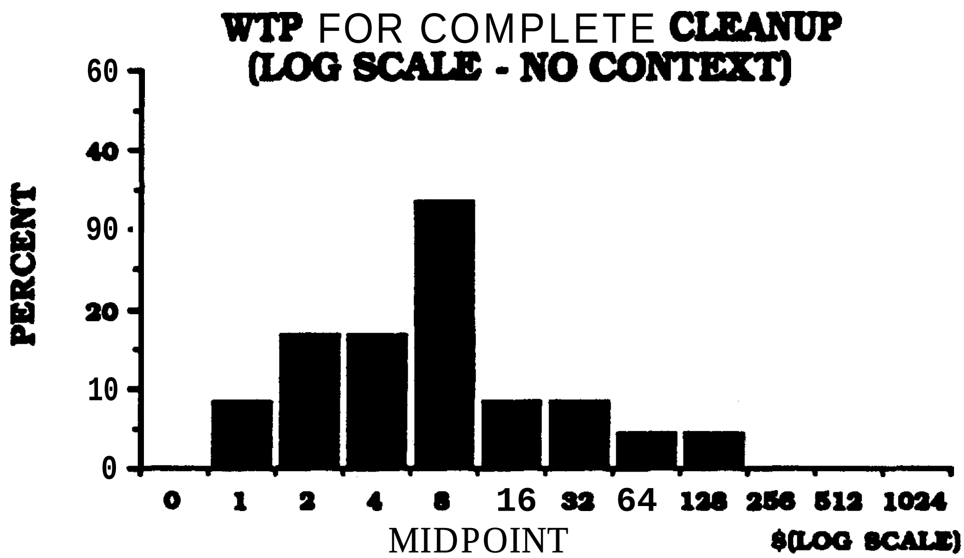


FIGURE 5.3: WTP FOR PUBLIC TREATMENT PROGRAM
OCTOBER 1001- DENVER PRETEST

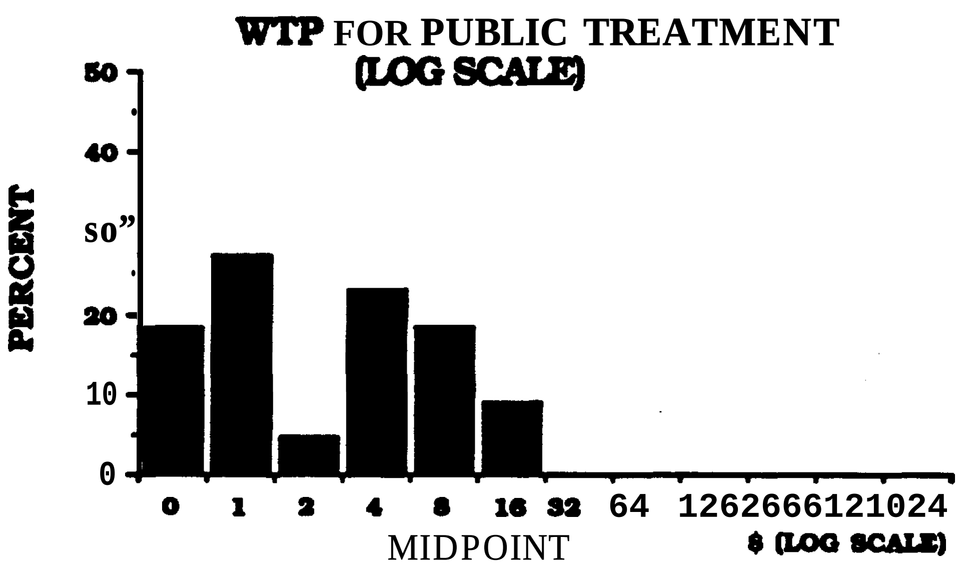


FIGURE 5.4: WTP FOR CONTAINMENT PROGRAM
OCTOBER 1991- DENVER PRETEST

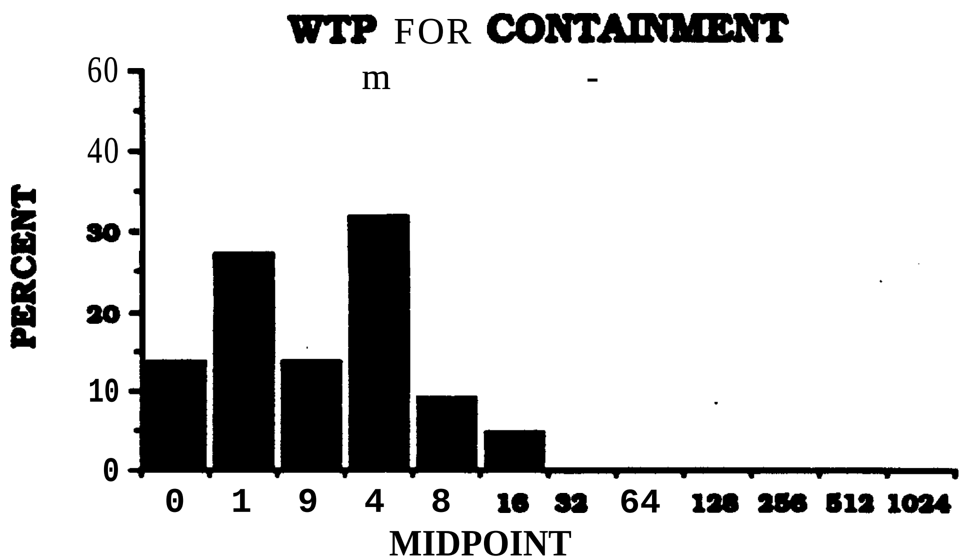


FIGURE 5.5: NATIONAL WTP - FULL CONTEXT
OCTOBER 1991- DENVER PRETEST

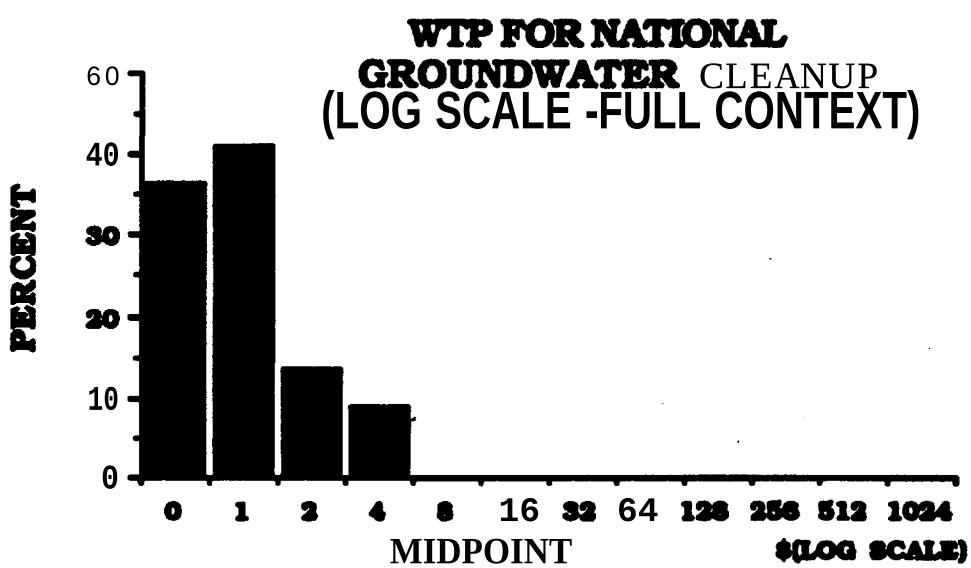


FIGURE 5.6: NATIONAL WTP - NO CONTEXT
OCTOBER 1901- DENVER PRETEST

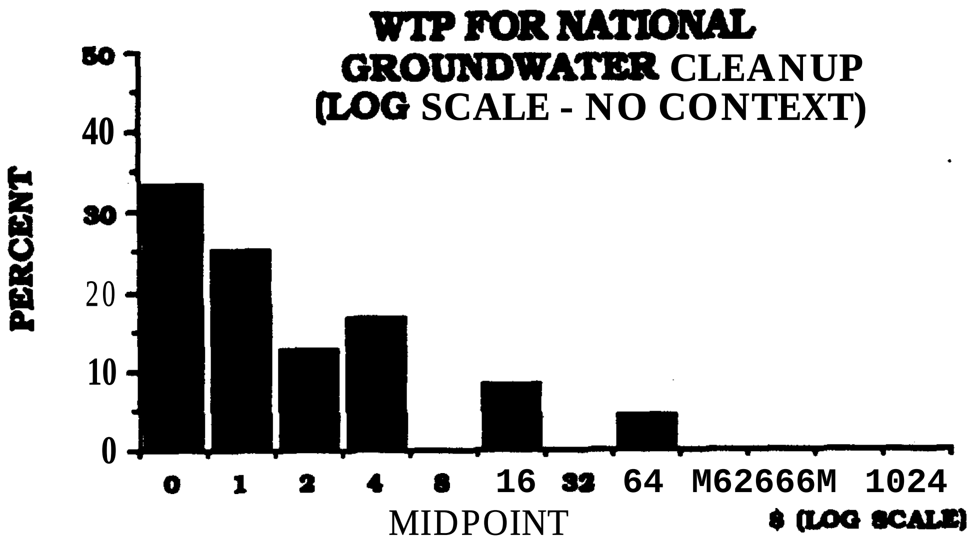


FIGURE 5.7: WTP WITH 1096 WATER SHORTAGE
OCTOBER 1991- DENVER PRETEST

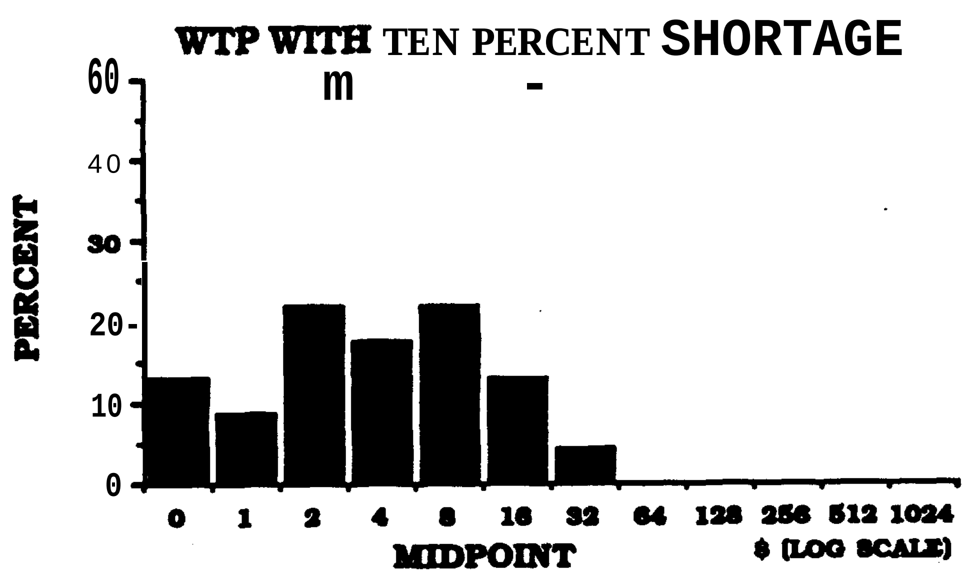
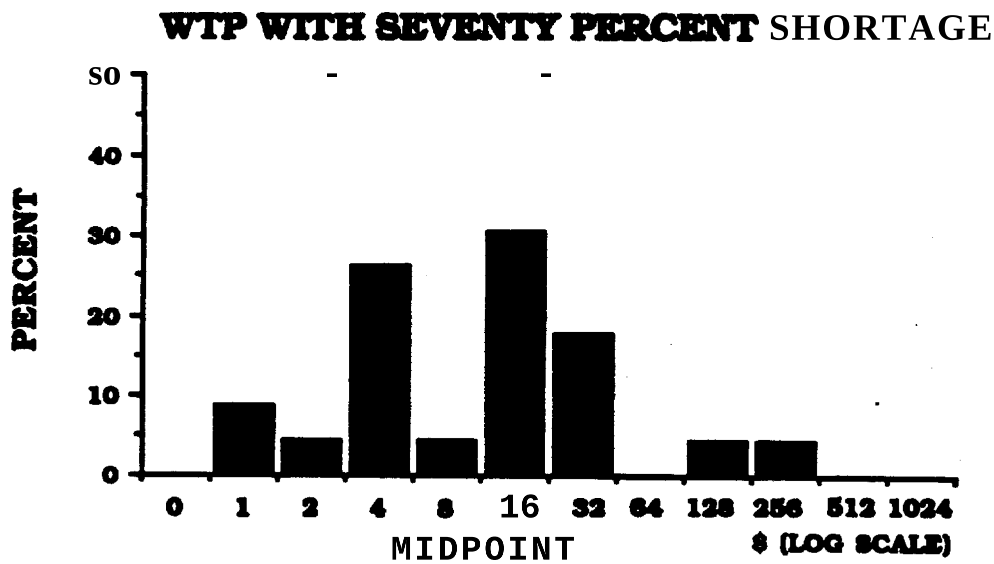


FIGURE 5.8:WTP WITH 70% WATER SHORTAGE
OCTOBER 1991- DENVER PRETEST



5.5 Estimates of Values

Table 5.3 presents the mean willingness to pay for the various scenarios from the Drover pre-test of the shortened instrument. The willingness to pay for complete groundwater cleanup shown is the reduced willingness to pay (the raw willingness to pay adjusted for self-reported embedding). Values for the alternative scenarios are calculated from this reduced WTP based on the adjustments reported in the different versions of the survey.

The full-context Versions A, B, C and D are treated separately from the no-context Version E for WTP for complete groundwater cleanup. There is not a significant statistical differenCE between the means of the context and no context WTP for complete groundwater cleanup (t(28.7) = 0.88, ns) even though the mean WTP is considerably higher (55% higher) in the no-context condition than with full context. However. there is a significant statistical difference between the variances in the two conditions (hence the adjusted t-test above) with the variance in the no-context condition being considerably higher (F (23.89) = 2.24. ns).

Similarly, there is not a significant statistical difference between the means of the willingness to pay for the national groundwater cleanup

TABLE 5.3: WTP FOR DIFFERENT SCENARIOS
DENVER PRETEST - OCTOBER 1991

WTP FOR	MEAN	STD DEV	MIN	MAX	N
COMPLETE CLEANUP WITH 4096 SHORTAGE					
FULL CONTEXT	11.09	21.73	0.10	200.00	90
NO CONTEXT	17.26	32.56	0.50	160.00	24
CONTAINMENT	3.08	3.20	0	12.00	22
PUBLIC TREATMENT	4.28	5.17	0	20.00	22
NATIONAL CLEANUP					
FULL CONTEXT	1.02	1.30	0.02	5.00	22
NO CONTEXT	5.92	16.32	0.01	80.00	24
10% SHORTAGE	**7.31**	**8.95**	**0**	**40**	**23**
70% SHORTAGE	**26.51**	**45.79**	**0.40**	**200.00**	**23**

program (t(23.3) = 1.46, ns), while the variance In the no-context condition is higher than in the full context condition (F(23,21) = 156.30, p < 0.0001).

Following the complete valuation and disembedding question a question asked the individuals to state their component breakdown of their total valuation between use, altruistic, bequest and existence values. Table 5.4 presents the means of these percent breakdowns and the values calculated according to these allocations of values. These are presented for the Ml-context versions only. The non-use value is the sum of the bequest and existence values. This represents one of the three approaches available for measuring non-use values.

TABLE 5.4: COMPONENT PERCENTS AND VALUES
(STD DEV) n = SAMPLE SIZE
FULL CONTEXT VERSIONS
DENVERPRETEST - OCTOBER 1901

VALUE	MEAN PERCENT	MEAN VALUE
USE	35.87% (25.15) n = 91	3.30 (4.92) n = 89
ALTRUIST	18.88 (13.47) n = 91	1.63 (2.14) n = 89
BEQUEST	26.32 (23.79) n = 91	2.46 (3.37) n = 89
EXISTENCE	18.92 (25.91) n = 91	3.77 (21.31) n = 89
NON-USE	45.25 (28.81) n = 91	6.22 (21.30) n = 89

In a similar manner the national groundwater value can be decomposed into use and non-use values as presented in Table 5.5. As above. these values are presented for the full context version only. The national component value question included a category for OTHER uses than the first four listed. The mean total is greater than 100% as some individuals entered values summing more than 100%. The non-use value shown is the sum of the bequest and existence values for each Individual.

TABLE 5.5: COMPONENT PERCENTS AND VALUES FOR NATIONAL CLEANUP PROGRAM - FULL CONTEXT VERS1ON DENVER PRETEST - OCTOBER 1901

V .	**MEAN PERCENT**	**MEAN VALUE**
USE	33.04% (27.13) n = 23	0.45 (0.85) n=21
ALTRUIST	13.70 (11.80) n = 23	0.13 (0.19) n = 21
BEQUEST	31.52 (31.20) n = 23	0.26 (0.28) n=21
EXISTENCE	21.74 (29.02) n = 23	0.22 (0.49) n = 21
OTHER	0 (0) n = 23	0 (0) n = 21
TOTAL	100 (0) n = 23	1 06 (1.32) n = 21
NON-USE		0.47 (0.54) n = 21

Table 5.6 presents the three alternative approaches for estimating non-use values from the Denver pm-test. The first approach, percent splits, is the non-use value as presented in Table 5.4 above. The scenario

TABLE 5.6: THREE APPROACHES TO ESTIMATING NON-USE VALUES
DENVER PRETEST - OCTOBER 1991

METHOD	MEAN NON-USE VALUE (STD DEV) SAMPLE SIZE
PERCENT SPLITS	$6.22 (21.30) n = 89
SCENARIO DIFFERENCE	4.70 (5.88) n = 22
EXTRAPOLATION	4.29 (13.76) n = 23

difference approach calculates the mean difference between the complete groundwater cleanup value minus the value for the public water treatment program from Version C. The extrapolation approach is the mean estimated WTP for complete groundwater cleanup if faced with a zero percent water shortage. This is calculated from Version D respondents by fitting a quadratic equation to the WTP values when faced with a 10%, 40% or 70% water shortage. The predicted WTP when facing a zero percent water shortage represents non-use values.

5.6 Final Survey Instruments

The values derived from the Denver pre-test can not be statistically analyzed for comparability to the values derived from pre-testtng of the full information/ full context surveys because of changes made in the scenarios being valued. Changing the magnitude of the water shortage from 50% in the full information survey to 40% for the shortened survey would arguably lower the valuation for complete groundwater cleanup. Confounding this interpretation of the pm-test values is the confusion respondents experienced with the concept of a 50-50 chance of the shortage occurring. From verbal protocols and retrospective reports it was obvious that many individuals were not applying a 50-50 chance to a 50% water shortage but were thinking that the 50-50 chance was the cause of the 50% shortage figure.

If some individuals “properly” calculated the expected water shortage as 25% and some treated it as a 50% water shortage the mean value for complete groundwater cleanup from the full information/full context survey will be comparable to a value for a 40% water shortage scenario as considered in the shortened survey. The mean reduced WTP from the full information/ full context survey of $9.75 for the October pre-test is lower than the mean reduced WTP from the Denver pre-test of $11.09. The results of the Denver pre-test are considerably less than values expected from a limited information/ limited context survey of $17-$18 as discussed in Section 4.8. Thus, it was concluded that the values between the full information/ full context survey and the shortened survey instrument were stable.

Further, the lack of comments in the debriefing survey from the October 1991 Denver pre-test suggesting scenario rejection indicated that the shortened instrument had deleted or appropriately re-worded information or context that was leading to scenario rejection in the full information survey instrument. Thus, we concluded that the shortened instrument retained the Information and context relevant to individuals for constructing values for complete groundwater cleanup which allowed us to proceed to a full national mail survey.

Following the Denver pre-test minor changes were incorporated into the shortened survey instrument prior to mailing. The adjustment schedules used in the valuation questions for alternative scenarios were altered slightly following the Denver pre-test. Respondents uniformly valued containment public treatment and national groundwater cleanup less than complete cleanup: thus, the adjustment scales did not need to include options of over 100% of the value of complete cleanup. For the containment option this scale was presented as 0% to 120%+ in the Denver pre-test instrument. In the mail survey instrument the scale was set from 0% to 100%. For the national groundwater versions (both full context and limited context) the scale for the pre-test ran from 0% to 200%+ and in the final design from 0% to 100%+. For the public treatment version the scale ran from 0% to 100% for both the pre-test and the final version. For the change in degree of water shortage the scales for the pre-test and the final design were identical running from 0% to 100% for the 10% water shortage scenario and from 100% to 400%+ for the 70% water shortage scenario.

In the description of the hypothetical scenario a statement was added that the landfill practices which led to the groundwater contamination were believed to be safe in the past. This was included to further ensure that individual did not scenario reject due to an assignment of responsibility to other parties.

The description of the containment scenario was reworded slightly to emphasize to individuals that this option would not completely clean up the contamination. The description of the water rationing option was changed to include information regarding how much water households typically use for different activities and to emphasize that households would have to reduce water usage if this option were chosen. Providing individuals with information regarding water usage in the household allows them to consider where they would have to decrease their own water usage and thus allows them to better evaluate such an option.

In the containment option description a statement was added that future generations would have to pay for their own operation and maintenance costs to emphasize the allocation of costs across generations if this option were chosen. No substantial changes were made in wording or format for either the public treatment or the national groundwater cleanup versions. Version D of the survey regarding valuation of complete groundwater cleanup if faced with either a 10% or 70% water shortage was reworded to clarify the alternative scenarios being considered and to increase Information and context given to the respondent. A question was added which first presented the new scenario to be valued stating the change in the hypothetical water shortage the community faced. Immediately following this description of the alternative scenario, individuals were asked how satisfied they would be with the rationing option if they faced the level of shortage hypothesized. This reminded individuals of alternative solutions to the complete groundwater cleanup.

Version E was changed to be the exact same as all other versions up to the section on the national groundwater cleanup. Only in the national section is the context changed between versions E and B. Changing context in the initial valuation question would make it impossible to test for effects of context change in the national valuation section so context changes were restricted just to the national section.

Finally, for the mail survey version a question was added in the socio-demographic section of the survey asking individuals their present employment status.

5.7 Conclusion

Changes to the full information/ full context survey instrument were made based on (1) the results of the verbal protocols, retrospective reports and pre-testing, (2) new technical and policy formation provided by the Office of Solid Waste at EPA and (3) reformatting and redesign to make the survey a mailable instrument. Changes made in response to analysis of the full information/full context survey corrected the presentation of information and context which had potentially created confusion and/or scenario rejection (such as the trust fund, repeated referendums and 50-50 chance of water shortage). In addition, information which respondents indicated was not relevant to value construction was deleted or minimized. Changes were made to the hypothetical scenario based on new technical information (size of contamination and degree of water shortage) and new scenarios added (containment and national valuation) in response to technical information from and policy needs of EPA.

The survey was partitioned into five different versions to explore a variety of alternative scenarios and theoretical questions. Separating the valuations of alternative programs snowed the survey to be shortened to a mailable length while retaining all relevant information. Re-testing of the shortened survey instrument with 117 randomly selected individuals in a Denver market research center showed that the shortened survey instruments indeed retained the information and context relevant for value construction as values remained stable between the original pre-test and Denver pre-test.

Chapter VI

Sample Design, Administration and Results of the National Mail Survey

6.1 Introduction

This chapter discusses the descriptive results from the implementation of the contingent valuation survey. Section 6.2 describes the sample design and survey administration. section 6.3 describes the survey response rate and the geographical distribution of the survey. Section 6.4 describes demographic information on the survey respondents. section 6.5 provides simple statistics from the survey including means and distribution of important variables. Section 6.6 concludes the chapter with a description of the facsimile surveys, which are contained in Appendix D.

6.2 Sample Design and Survey Administration

Surveys were designed consistent with the Dillman Total Design Method (Dillman, 1978). The TDM procedure aims to maximize response rates through specific destgn and Implementation strategies. The procedure Includes personalizing the mailing to include a cover letter hand-signed in blue ink, hand-stamped envelope. a follow-up postcard and a second mailing to households that did not respond to the survey following the first mailing. The surveys were printed and folded into a booklet measuring 8 inches by 6 inches. The survey were all twelve pages long, including the cover and space for comments. Each survey had a stamped identification number on the cover for purposes of tracking responses and identifying the surveys by region for data analysis.

All mailings were on Tuesdays so as to avoid havtng respondents receive the survey on days which they either normally receive a lot of junk mail (i.e., Wednesdays) or when they are less likely to examine their mail carefully (Le., Friday evenings). In the first mailing, each household in the sample received a version of the survey, a cover letter, and an addressed, stamped envelope to return the survey to us. For the first mailing only, the package also included a two dollar bill, to thank respondents for their time and to encourage them to fill out and return the survey. This monetary incentive is not part of TDM, but we have found in past survey research that monetary incentives increase response rates significantly (Deane. et al., 1989). One week after the initial mailing, a postcard was sent reminding respondents of the importance of completing and returning the survey. If a response was not received after two weeks, a second survey, cover letter and self-addressed, stamped envelope were mailed. However. this second mailing package did not contain another two dollar bill.

Examples of the mailing enclosures are presented in figures 6.1-6.3. The cover letter (Figure 6.1) is designed to introduce respondents to the topic and to remind respondents of the importance of returning the questionnaire. It describes in general what the survey is about, who should till it out, and who@ conducting the research. Figures 6.2 and 6.3 present the reminder postcard and follow-up letter, respectively.

FIGURE 6.1: COVER LETTER FOR NATIONAL MAIL SURVEY

October 29, 1991

Mr. John Doe
3333 Oak Ave
Somewhere, USA 99999

Dear John Dot:

You arc one of a small number of households nationwide who arc being asked what they think about groundwater contamination. In the United States this is an issue of increasing concern. However, little is known about what people think about groundwater contamination and how they respond to the impact it may have on their lives. In order to better assess what should be done about this problem we need the benefit of your experience.

[n order for the results to truly represent the opinions and experience of people who live in the United States, it is very important that each questionnaire be completed and returned. It will take you about 15 minutes. Your answers will be combined with others in the United States to form a profile of views on groundwater contamination.

Since this questionnaire asks specifically what your household thinks should be done about groundwater contamination, wc ask that it be filled out by an adult in your household. You can be assured of complete confidentiality. In fact. your name will rover be associated with this information. The number on the questionnaire is only so your name can be checked off the list when it is returned.

Since your responses arc so valuable to us, we enclose a $2 as a token of our appreciation.

[f you would like to receive ● free summary of the survey results, please indicate so in the box provided at the end of the survey.

Many thanks for your help with this important effort.

Sincerely,

Gary McClelland
Pro D re o

FIGURE 6.2: REMINDER POSTCARD FOR NATIONAL MAIL SURVEY

November 5, 1991

Last week a questionnaire was mailed to you seeking information which is crucial in evaluating what people think should be done about groundwater contamination in the United States.

If you have already completed and returned the questionnaire, accept our sincere thanks. If not, please do so today. The issue of groundwater contamination is a matter of increasing concern. Therefore, it is extremely important that your answers also be included in the study.

If by some chance you did not receive the questionnaire, or it was misplaced, please write us and we will get another one in the mail to you immediately.

Sincerely,

Gary McClelland
Project Director

FIGURE 6.3: SECOND MAILING LETTER FOR NATIONAL MAIL SURVEY

November 19, 1991

Mr. John Doe
333 Oak Drive
Denver, CO 80236

Dear John Doe:

I am writing to you about our study of what people think should be done about Groundwater Contamination in the United States. To date, wc have not yet received your completed questionnaire.

The large number of questionnaires returned is very encouraging. But whether we will be able to describe accurately what people think about groundwater contamination in the United States depends on you and the others who have not yet responded. This is because our past experiences suggest that those of you who have not yet sent in your questionnaire may have very different opinions compared to those who have responded.

This study has been undertaken in the belief that people's views on groundwater contamination should be incorporated into public management policies. Your opinions will be extremely valuable towards evaluating the worth of such programs. The usefulness of our results depends on how accurately we arc able to describe the views of the people of the United States.

In case our previous correspondence did not reach an adult in your household whose response is needed, a replacement questionnaire is enclosed. We urge you to complete and return it as quickly as possible.

We'll be happy to send you a copy of the results if you want one. Simply put your name, address, and "mpy of results requested" on the back of the return envelope.

Your contribution to the success of this study will be appreciated greatly.

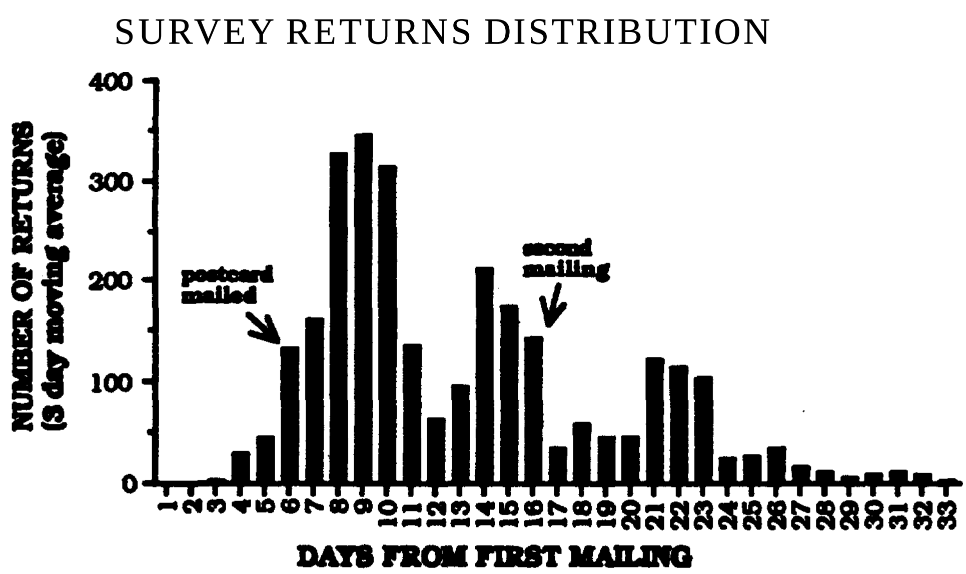
Most sincerely,

Gary McClelland
Project Director

6.3 Survey Response

Five thousand surveys were mailed on Tuesday, October 29, 1991. One week later, November 4, the reminder postcard was mailed to everyone. Two weeks later, on November 19, the second copy of the survey was sent to individuals who had not responded and had not been deleted due to bad addresses. Figure 6.4 shows the distribution of returns. A three day moving average of responses is shown starting from the day the first surveys were mailed. The DAYS FROM FIRST MAILING are counted as working days (excluding weekends and holidays).

FIGURE 6.4: TEMPORAL DISTRIBUTION OF SURVEY RESPONSES
NATIONAL MAIL SURVEY



As can be seen from Figure 6.4 the lag time from the first mailing to the peak of the first responses was about nine working days. From the post card mailing to the next peak is eight days and from the second mailing to the third peak is about five working days.

Table 6.1 indicates the distribution of surveys by survey version and by region. The regions are those as defined for the data analysis (see Chapter VII: Analysis of Results). Anonymity was maintained for the purposes of data analysis. Surveys were numerically coded purely to keep track of the response rate, to prevent mailing duplicate survey to those respondents who returned the survey prior to the second mailing and to aid in the coding of regional dummy variables for data analysis.

TABLE 6.1: SURVEY DISTRIBUTION BY REGION AND VERSION NATIONAL MAIL SURVEY

VERSION	A	B	B	C	D	E	TOTAL
REGION							
LAKES	174	175	129	175	178	175	1006
MIDATLAN	104	103	98	104	105	103	617
MIDWEST	56	56	5	57	55	56	285
MOUNTAIN	31	31	30	32	31	31	186
NEWYORK	95	97	110	97	96	96	591
NORTHEAS	60	60	66	59	5'7	60	362
NORTHWES	32	32	14	32	32	33	175
SOUTH	173	171	21	168	169	170	872
SOUTHWES	97	97	27	99	100	99	519
WEST	78	78	0	77	77	77	387
		900	500	900	900	900	5000

Table 6.2 indicates the response rate by version for the survey. Version B' is the over-sample mailed to zip codes in which groundwater contamination is known to exist because of sites on the NPL.

TABLE 6.2: SURVEY RESPONSE RATES- NATIONAL MAIL SURVEY

VERSIONS	A	B	B	C	D	E	TOTAL
MAILED	900	900	500	900	900	900	5000
SAMPLE SIZE	**816**	**816**	**453**	**816**	**816**	**816**	**4533**
RETURNED	**517**	**523**	**289**	**524**	**509**	**512**	**2874**
% RESPONSE	**63.4%**	**64.1%**	**63.8%**	**64.2%**	**62.4%**	**62.7%**	**63.4%**

The table shows the sample size per version. Bad addresses were allocated proportionately by survey version for purposes of determining survey response rates. From this we can calculate the response rate as the percentage of the sample returned prior to the cutoff date. The differences between response rates by survey version are not statistically reliable (x^2 (d.f. 5) = 0.95, n.s.).

Table 6.3 shows a more detailed breakdown of the survey response. Of the initial 5000 surveys mailed 467 were returned by the postal service as undeliverable (9.34% of the initial mailing). Although it is not possible to determine the characteristics of the group of people who have moved we assume that they represent a random portion of our mailing group and may thus treat the remaining 4533 "good" addresses as a random sample. Of the

TABLE 6.3: ANALYSIS OF GROUNDWATER SURVEY RESPONSE

SURVEYS MAILED	5000	
BAD ADDRESSES	467	
SAMPLE SIZE	4533	
NOT RETURNED	1659	
RETURNED BLANK	187	
RETURNED ANSWERED	2687	
ITEM NON-RESPONSE ANALYSIS		
DID NOT ANSWER WTP QUESTION		141
DID NOT ANSWER WTP QUESTION and/or EMBEDDING QUESTION		372
ANSWERED ENOUGH QUESTIONS TO PERFORM REGRESSION ANALYSIS		1983

4533 "good" addresses in our sample, 1659 did not respond to any of the mailings by the cutoff date of Friday, January 3, 1992. Between the cutoff date and September 1, 1992, an additional 25 surveys were received which have not been included in the data analysis. One hundred and eighty-seven surveys were returned blank. Of the 4533 in the sample 2687 (or 59.26%) were returned with at least one question answered. Counting the "returned blank" as responses to the survey the total response rate (as a portion of the 4533 sample) is 63.40%.

Not all respondents answered all questions to the survey which means that some information will be missing for data analysis which lowers the number of observations used in the analysis. One hundred and forty-one individuals did not answer the WTP question. Three hundred and seventy two individuals did not answer the WTP question and/or the disembedding question making it impossible to calculate a reduced Willingness to pay for these individuals. One thousand nine hundred and eighty three individuals answered all of the questions used in the regression analysis.

Of particular interest is the possibility that there are significant differences between the group who answered all of the questions and those who "self-selected" out of the regression sample by not answering all relevant questions. Of even greater significance is the possibility that individuals who did not answer all of the questions and especially those who did not even answer the survey have different values than those who did answer all of the questions. Simple ignoring these groups and treating the 1983 individuals used in the regression analysis as representative of the entire population may lead to overestimates of values if people failed to respond to the survey simply because they did not put enough value on cleaning up groundwater to make it worth their time to respond to the survey. The question then arises as to whether these non-responding individuals should be treated as having zero values in calculating the value of groundwater cleanup for the population as a whole.

Table 6.4. shows the mean value for the raw WTP for the different segments of the sample who answered at least the WTP question. The "FULL SAMPLE" column shows the mean raw WTP for the entire group of respondents who answered the WTP question. The WTP VALUE ONLY column shows the mean raw WTP for the group of individuals who answered the WTP question but not the disembedding question. The WTP AND DISEMBED column indicates the mean raw WTP for the group of individuals who answered the WTP and the disembedding question but not all of the other questions necessary to be included in the regression analysis. The final column indicates the mean raw WTP for the individuals who answered all of the questions necessary for regression analysis.

TABLE 6.4: RAW **WTP BY PORTION OF SAMPLE FULL SAMPLE, REDUCED WTP SAMPLE, REGRESSION SAMPLE**

	FULL SAMPLE	WTP VALUE ONLY	WTP AND DISEMBED	REGRESSION SAMPLE
mean	**$13.98**	**$6.79**	**$14.29**	**$14.76**
std dev	**35.43**	**12.53**	**48.47**	**34.57**
n	**2546**	**231**	**332**	**1983**

The group answering just the WTP question and not the disembedding question has a significantly lower mean WTP than the other respondents to the survey (both those who answered the WTP and disembedding question and those who are in the regression sample) ($t(2543) = 3.032$. $p < .0025$). On the other hand there is not a significant difference between those who answered the WTP and disembedding question and were not in the regression sample and those who were In the regression sample ($t(2543) = 0.226$, $p < .82$).

This suggests that individuals with a lower willingness to pay were not willing to continue answering survey questions and were “self-selected” out of further analysis. Treating the remaining respondents in the regression sample as representative of the population would lead to an overestimate of the true mean WTP for groundwater cleanup. While the Individuals who answered the WTP question but not the disembedding question had a positive WTP (mean = $6.79) a conservative approach to estimating the true mean WTP for the entire population would be to treat all non-respondents (those who did not answer the survey and those who did but experienced item non-response) as having zero values. This is consistent with our earlier finding that predicted values for non-respondents using a selection model were quite low relative to respondents.

Finally, since only 141 respondents failed to answer the WTP questions (about 5.2% of respondents). use of a selection moded to attempt to predict the values of these respondents is not appropriate. The small number of non-responses to the WTP question suggests that the cognitive survey design process greatly reduced scenario rejection which occurred in as much as 35% of the sample in previous studies.

6.4 Demographics

Table 6.5 shows the mean and modal responses to the demographic questions at the end of each of the surveys. As the table shows, the average survey respondent was a Caucasian male, about fifty years old, with a middle income and at least a high school education. The cover of the survey asked that 'This survey should be completed by a head of your household. There was no effect of survey version on demographic variables.

6.5 Variable Means and Distributions

Means and frequencies for all variables, by version, are presented with the five survey versions in Appendix A. Table 6.6 lists the versions, any computations performed on a variable, number of responses to the question

TABLE 6.5: RESPONDENT DEMOGRAPHICS - NATIONAL MAIL SURVEY

Variable	Mean or Mode and Percent
Gender	**68% male**
Age	50.9 years
# of Children in Household	1.1
# of Middle-Aged People in Household	1.7
# of Elderly People in Household	0.8
Education Level	Less than Complete High School (10.0%) Completed High School (20.0%) Some College (23.9%) Completed College (18.9%) Post-Graduate Work (19.4%)
Income	Mean = $43,503 Mode = $35,000 Less then $10,000 (8.5%) $10,000-19,999 (16.0%) $20,000-$29,999 (15.5%) $30,000-$39,999 (16.7%) $40,000-$49,999 (12.3%) $50,000-$59,999 (10.4%) Greater than $60,000 (20.6%)
Ethnic Group	89.9% Caucasian 4.6% African American 2.3% Hispanic 1.4% Asian 0.5% Native American 1.3% other
Employment	Employed Full Time (56.1%) Employed Part Time (6.0%) Full Time Homemaker (3.4%) Unemployed (2.1%) Retired (27.3%) Student (1.3%) other (3.9%)

(N), and means and standard deviations for the six WTP values. Reduced WTP, which is WTP for complete clean-up of groundwater at a 40% contamination level, was computed by multiplying respondents' given WTP value (Q11) by the proportion of this value allocated to groundwater clean-up (Q13 x .01). All of the other WTP values were obtained by multiplying the respondents* reduced WTP values by the appropriate proportionns

As Table 6.6 indicates, the standard deviations around all of the WTP means are quite high. The raw means indicate that respondents preferred complete groundwater treatment to either the containment or public treatment options. Preference for complete groundwater treatment over containment, $F(1,403) = 161.48$, $p < .001$, and over public treatment, $F(1,399) = 37.65$, $p < .001$, both were highly reliable.

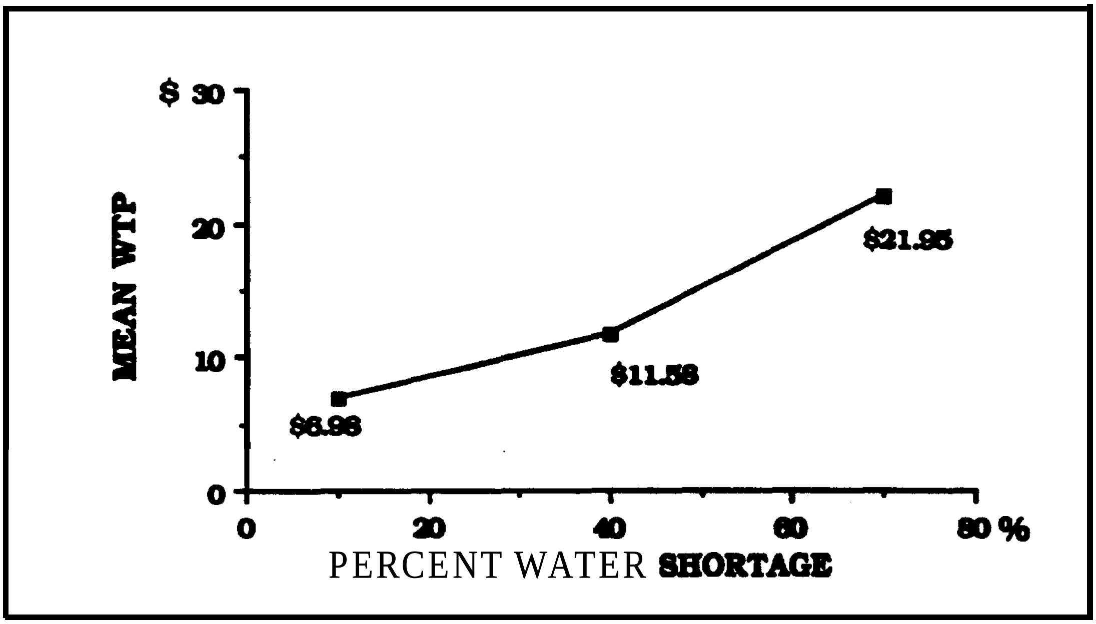
The means also indicate that respondents distinguished between complete groundwater treatments when facing 10%, 40% and 70% water shortfall. As Figure 6.5 shows, respondents valued treatment when facing 70% water shortfall over treatment when facing 40% water shortfall, and treatment when facing 40% water shortfall over treatment when facing 10% water shortfall This linear effect was highly reliable ($F(1,387) = 98.17$, $p < .0001$). As illustrated in Figure 6.5 however, the diffidence in WTP value from 10% water shortfall to 40% water shortfall was less than was the difference in WTP value between 40% water shortfall and 70% water shortfall. This quadratic effect also was reliable ($F(1,387) = 14.70$, $p < .0001$).

TABLE 6.6: WILLINGNESS TO PAY VALUES AND THEIR COMPONENTS

NATIONAL MAIL SURVEY

VARIABLE	VERSION	COMPUTATION	N	MEAN	STD DEV
Reduced WTP: WTP for complete water shortfall	ALL	WTP x Percent for G.W. treatment	2315	11.S8	26.00
Percent for G.W.	D		2546 2343	13.98 75.82	35.44 35.37
WTP for complete clean-up (10% water shortfall)	D	% for 10% clean-up x Reduced WTP	408	6.98	19.72
Percent for 10%			442	46.52	32.54
WTP for complete clean-up (70% water shortfall)	D	% for 70% clean-up x Reduced WTP	389	-	46.07
% for 70%			414	166.24	72.74
WTP for national complete clcan-up	B B,	% for National x Reduced WTP	1019	2.28	8.70
% for National			1117	12.20	19.46
WTP for containment of GW	A	% for containment x Reduced WTP	404	5.96	11.36
% for containment			445	42.85	34.43
WTP for public treatment of GW	C	% for pub. treatment x Reduced WTP	400	7.98	24.62
% for public treatment			.441	50.30	40.54

FIGURE 6.5: WTP AS A FUNCTION OF PERCENT OF WATER SHORTAGE CAUSED BY GROUNDWATER CONTAMINATION - NATIONAL MAIL SURVEY



Figures 6.6 through 6.9 show the frequency distributions on log scales for the WTP values for complete clean-up (termed “reduced WTP), containment of groundwater, public treatment of groundwater, and national clean-up of groundwater. Reduced WTP is the respondent’s value for complete groundwater clean-up at a 40% water shortfall level. Figures 6.10 and 6.11 show the frequency of respondents’ reduced WTP values for complete clean-up of groundwater when facing a 10% water shortage and a 70% water shortage.

Figures 6.6 through 6.11 show that all_ distributions are highly variable. The log scale reduces the strong positive skew, but much skew still remains. Note also that even on a log scale the national WTP values are far from normally distributed because of the large number of zero values. Fully 36% of the WTP values for national clean-up were equal to zero.’

FIGURE 6.6: REDUCED WTP FOR COMPLETE GROUNDWATER CLEANUP
NATIONAL MAIL SURVEY

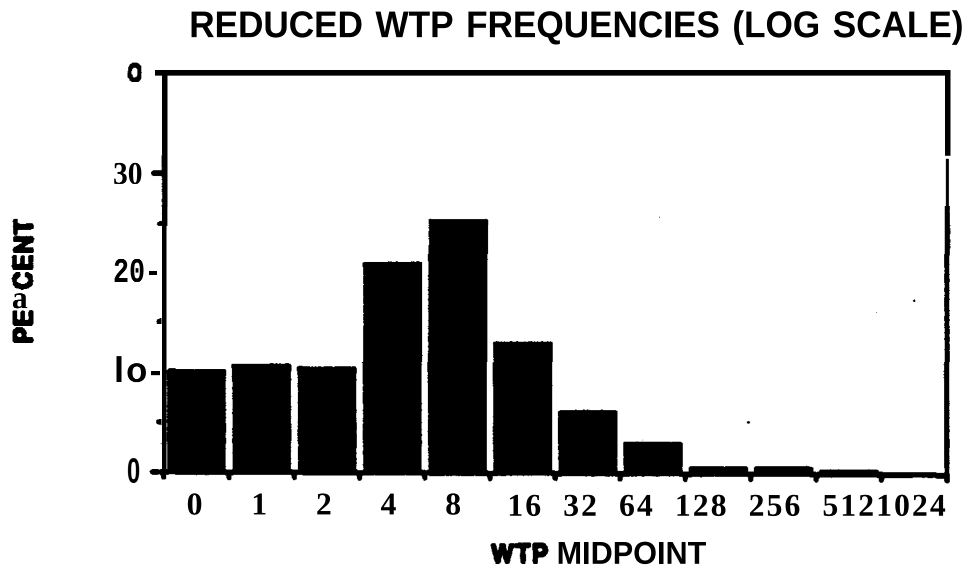


FIGURE 6.7: WTP FOR CONTAINMENT OPTION
NATIONAL MAIL SURVEY

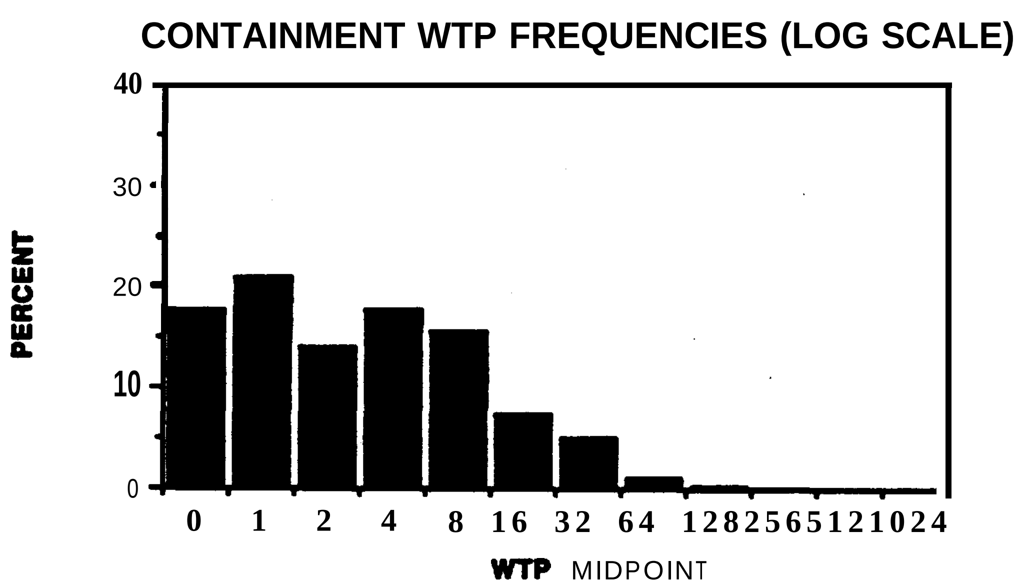


FIGURE 6.8 WTP FOR PUBLIC WATER TREATMENT OPTION
NATIONAL MAIL SURVEY

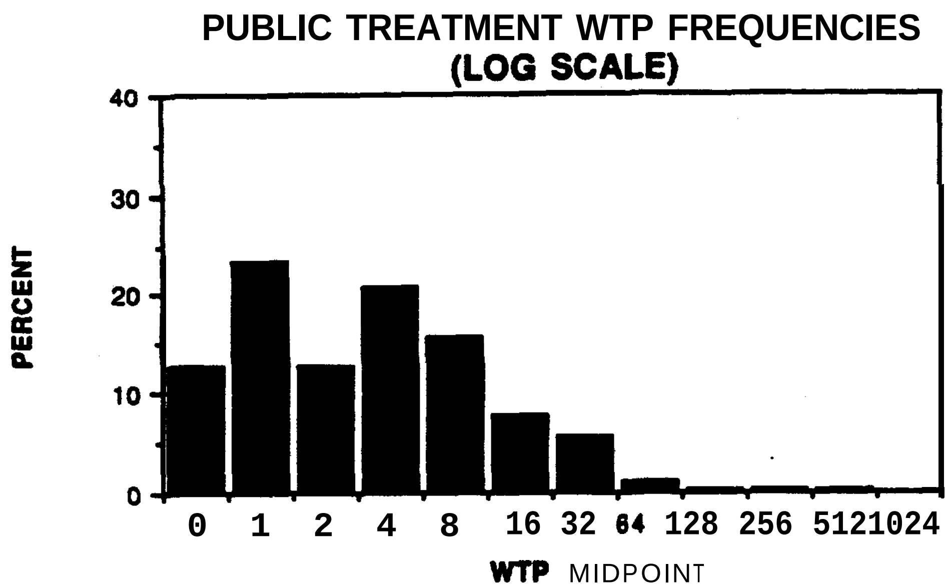


FIGURE 6.9: WTP FOR NATIONAL CLEANUP PROGRAM
NATIONAL MAIL SURVEY

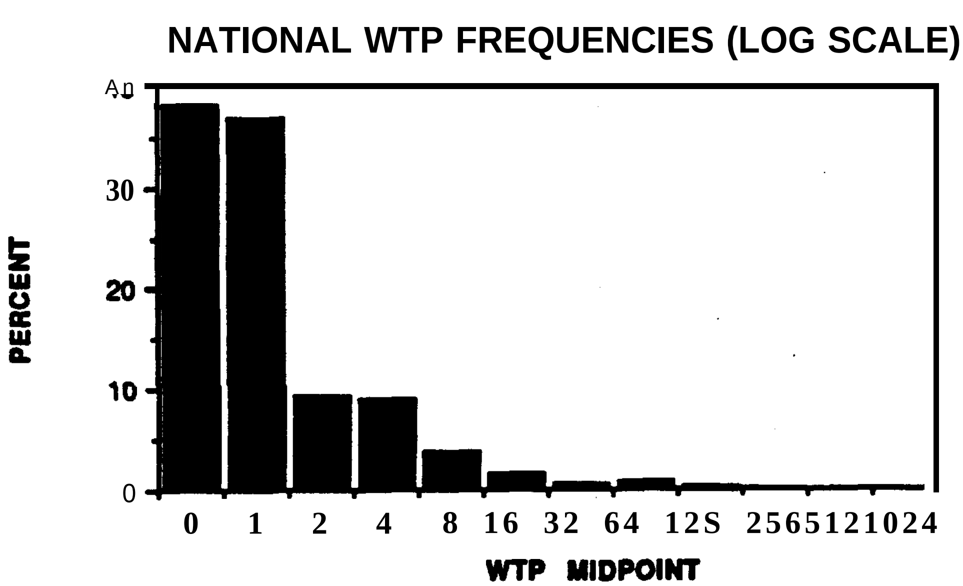


FIGURE 6.10: WTP FOR COMPLETESCLEANUP WHEN FACING A 10% WATER SHORTAGE
NATIONAL MAIL SURVEY

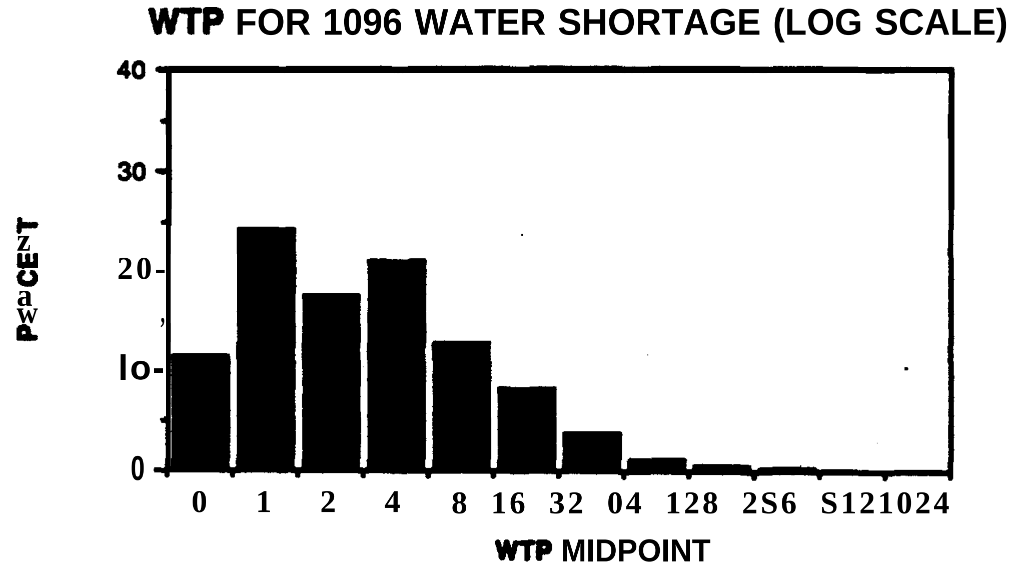
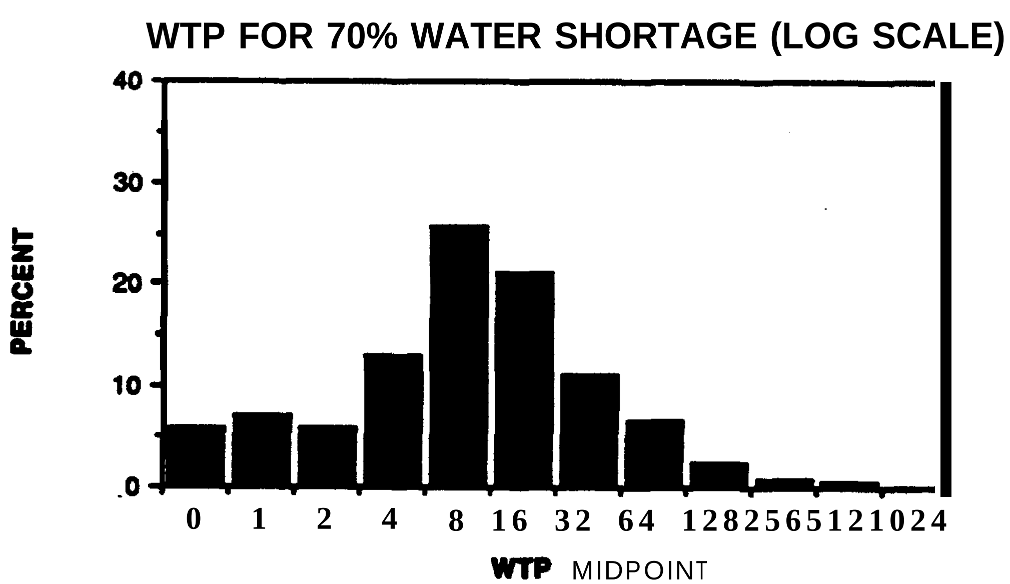


FIGURE 6.11: WTP FOR COMPLETE GROUNDWATER CLEANUP WHEN FACING A 70% WATER SHORTAGE
NATIONAL MAIL SURVEY



6.6 Facsimile Surveys

Appendix D presents the facsimile surveys for the national mail survey. The mean response or percent of respondents answering each question or item is presented in parentheses next to or with each question for each of the versions of the survey. The page letter-number in the upper right hand comer of each survey identifies the survey variant as discussed previously. The cover is shown in actual size. 8 inches tall by 6 inches wide, used for printing the national mail survey as suggested by Dillman (1978). The cover was identical for all five versions of the survey.